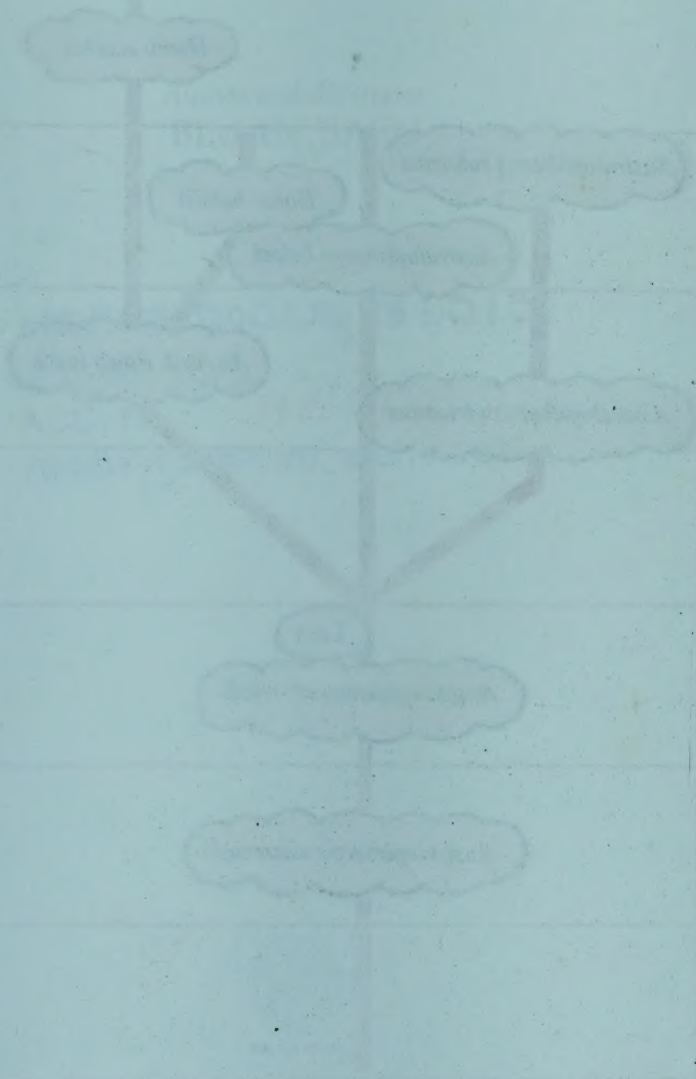
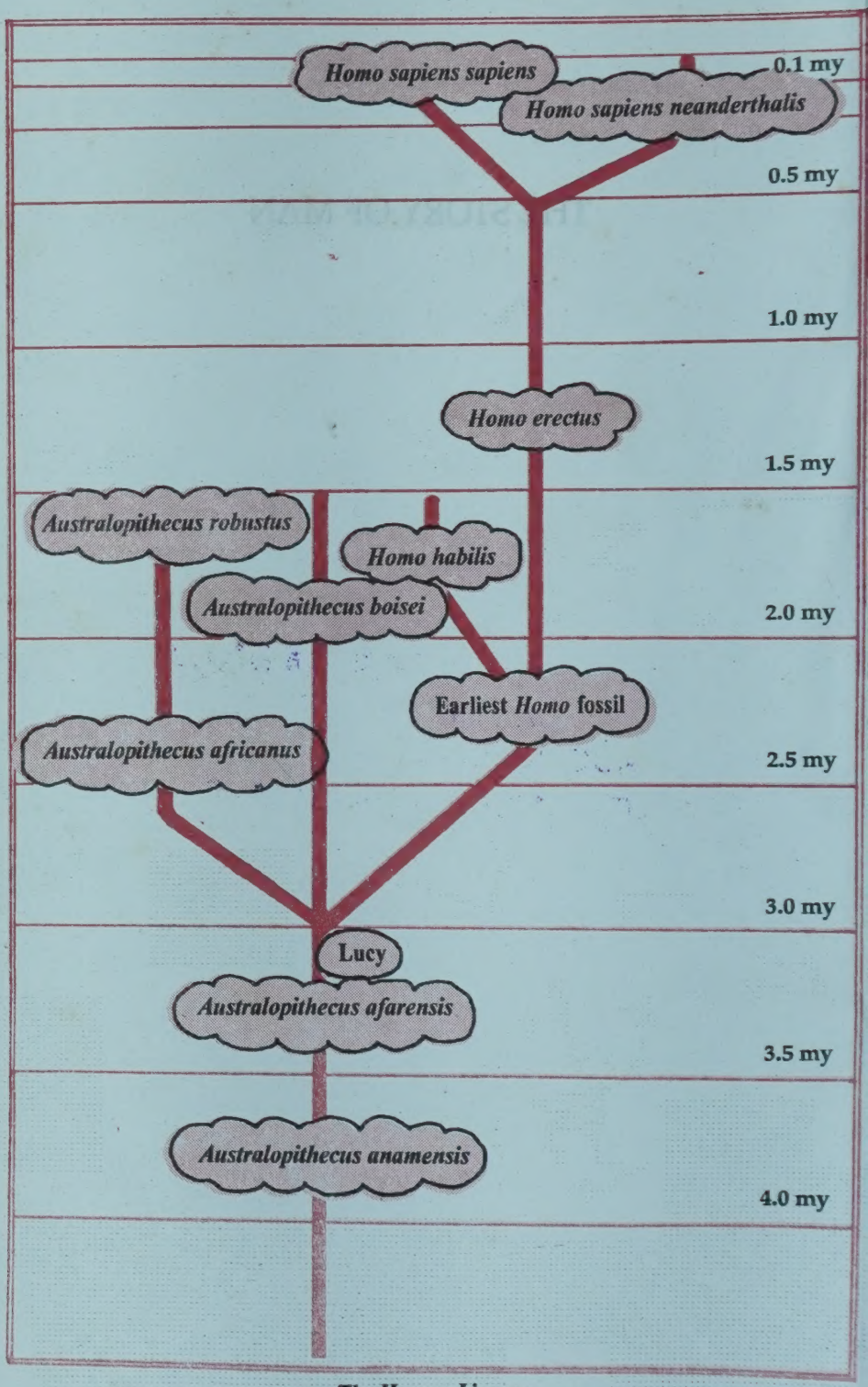
THE STORY OF MAN

Biman Basu

THE STORY OF MAN





The Human Lineage

Popular Science

THE STORY OF MAN

Author and illustrator
BIMAN BASU

ಕರ್ನಾಟಕ ಗಾಂಧೀ ಸ್ಮಾರಕ ನಿಧಿ (ರಿ)
ಪರಿಗ್ರಹಣ ಸಂಖ್ಯೆ:
ACC. No.: 11626
ಗಾಂಧೀ ಗ್ರಂಥಾಲಯ, ಬೆಂಗಳೂರು-1

NATIONAL BOOK TRUST, INDIA

ISBN 978-81-237-2057-9

First Edition 1997
Reprints 2010, 2011 (*Saka* 1933)
© Biman Basu, 1997
₹ 55.00

Published by the Director, National Book Trust, India
Nehru Bhawan, 5 Institutional Area, Phase II
Vasant Kunj, New Delhi-110 070

To

MADHU

who never tires of

asking me questions about everything

Contents

	Preface	ix
1.	Life in the Branches	1
2.	Apes that Walked	10
3.	The First Tool-makers	23
4.	Expanding Horizons	29
5.	The Neandertals	37
6.	First Words	45
7.	Modern Man Emerges	54
8.	An Abundance of Art	63
9.	The First Harvest	70
10.	The Question of Age	77
	Recommended Reading	81
	Index	83

Preface

The question of mankind's origin has always fascinated scientists, philosophers and laymen alike. But it remained a mystery till the second half of the nineteenth century, when T.H. Huxley and Charles Darwin first suggested a plausible link between apes and humans. Repugnant though it was for orthodox believers, the idea gradually took root through the work of palaeoanthropologists—people who search for human ancestors by studying fossil bones. Gradually, as new fossil evidence was unearthed, different pieces in the jigsaw puzzle of human origin started falling into place. Today, the picture is reasonably complete, although there still remain a few missing pieces.

From whatever has emerged so far, it is clear that mankind's journey from an ape-like creature living on trees some 8 million years ago to an intelligent creature capable of accomplishing astounding feats was not a smooth one. It was punctuated by many upheavals and dead ends. But more fascinating is the story of the handful of men and women who gave up the comforts of life to search for our distant ancestors in the hot tropical Africa and elsewhere, the story of their dogged work in the scorching sun, searching for a tooth, a piece of jaw or a fractured corner of a bone amid stone litter and shadows, with no guarantee of ever finding anything. The saga of their successes, as also failures, is no less exciting and enthralling than any detective thriller. The ingenuity of their methods for identifying a piece of jaw or a limb bone as belonging to an ape or a human-like creature, or finding out whether the creature

whose fossil skull they held could speak would put even Sherlock Holmes to shame!

My own interest in human evolution dates back to no more than a few years, since I became involved in the production of a radio serial on the subject. I had to prepare some background material for the scriptwriters. But after I had collected all that was available I was astounded by the wealth of information that lay before me. There was much more than could be presented in a few episodes of a radio serial. It deserved a more permanent place. The serial was a big success, but the thought of putting it down in a book form never left me. The opportunity came in the shape of an invitation from the National Book Trust who wanted a book on the subject for their popular science series.

But writing the book turned out to be far from the cakewalk I had expected it to be. When I tried to update the data, to my utter dismay I found that new fossil finds and theories were coming up almost by the day and making quite a lot of what I had written earlier irrelevant. Revising the text by keeping pace with the new finds almost became a nightmare. Yet I had a deadline to meet. As a compromise I gave up and settled for a cutoff date—July 1996. If any new fact has come up subsequently which is at variance with what I have written in the book I hope readers will pardon me.

I have received encouragement from many friends and colleagues to all of whom I am indebted. I am particularly indebted to Dr G.P. Phondke who was the main driving force behind the radio serial on human evolution and with whom I had the privilege of working for the serial. His valuable suggestions after going through the early drafts helped me a lot in preparing the final text. My friend Shankuntala Bhattacharya was kind enough to lend me her books which provided valuable reference material. I could have never finished writing the book without the constant vigil kept by Ms Manju Gupta of NBT who never tired of reminding me of the deadline (although I didn't quite stick

to the original one)! I am specially thankful to Shri C.G. Raphael who keyed in the text on computer and ungrudgingly carried out whatever changes I asked for. And, of course, I cannot forget the unflinching support I got from my wife Aloka in the form of the umpteen cups of tea at odd hours which certainly helped me maintain my tempo.

New Delhi
November 1996

BIMAN BASU

1

LIFE IN THE BRANCHES

Where did we come from? When did our ancestors appear on earth? These are questions that have bothered mankind for ages, and there have been as many answers as there are religions in the world. But common to all early ideas was the concept of 'creation'. It was almost universally accepted that the world and all its inhabitants—plants, insects, birds, animals and human beings—were created at the same time by some supernatural being, call it God, or whatever. No wonder, the idea of creation was ingrained in almost all religious faiths and humans were considered to be the supreme creation of God.

Science, however, looks at things differently. It tries to understand observed facts on the basis of logical explanations and evidence wherever possible.

It was the British naturalist Charles Darwin, who in 1871 first put forward the idea that humans have evolved from apes, in his book, *The Descent of Man*. Darwin based his hypothesis on his wide-ranging studies of plant and animal life, of different continents and islands of the world, which he carried out during a five-year voyage—from 1831 to 1836—on board the research ship *HMS Beagle*. On examining the hundreds of species of plants, animals and birds he had seen and collected during the voyage, Darwin could discern small changes in characters between similar species inhabiting different ecological niches. He summarised his findings in the book, *On the Origin of Species by Means of Natural Selection*, published in 1859, in which he described how one species could evolve into another more fit to

Charles Darwin, author of *The Descent of Man*

survive in a changed environment, by a process which he called *natural selection*. (The term 'survival of the fittest' was later used by the English philosopher Herbert Spencer.) Human beings, Darwin believed, evolved by a similar process.

Even before Darwin, Thomas Henry Huxley in his book, *Man's Place in Nature*, published in 1863, had made detailed comparison of human and ape anatomy that established the case for close relationship between humans and apes. Huxley suggested that our relationship to the ape is so close that an evolutionary link is inescapable! But, he admitted, it was difficult to predict exactly what the common ancestor might have looked like.

Darwin did not address the question of human evolution in the *Origin of Species*, confining himself merely to the hint that "light will be thrown on the origin of man and his history." It was left to Huxley's *Man's Place in*

Nature to present the first detailed discussion on the issue. Huxley conceded that we cannot tell which ape is closest to the human form: he used the gorilla for his comparison of bodily anatomy and the chimpanzee for the brain.

Darwin, like many of his followers, drew on Huxley's study to illustrate the close link between mankind and the apes. In the sixth chapter of his book, *The Descent of Man*, he listed a number of anatomical and embryological points confirming the closeness.

"Man is descended from a hairy, tailed quadruped, probably arboreal in its habits," Darwin wrote. "We must, however, acknowledge, as it seems to me, that man with all his noble qualities...still bears in his bodily frame the indelible stamp of his lowly origin."

Having identified a link between African apes and humans, Darwin went on to hypothesize that the human family arose in Africa, which we know today is true. Darwin also formulated the notion that a complex of human-like characteristics—walking on two feet, tool making, and an enlarged brain—evolved together. "If it be an advantage to man to have his hands and arms free and to stand firmly on his feet, of which there can be no doubt from his pre-eminent success in the battle for life, I can see no reason why it should not have been more advantageous to the progenitors of man to have become more and more erect or bipedal," Darwin wrote in his *Descent of Man*. "The hands and arms could hardly have become perfect enough to have manufactured weapons, or to have hurled stones and spears with true aim, as long as they were habitually used for supporting the whole weight of the body...or so long they were especially fitted for climbing trees."

When Darwin's *Descent of Man* was published, it created a furore as it went against the established religious beliefs. At the same time it provided scientists with a definite line of study to explore human origins.

If, as Darwin had suggested, our species did indeed evolve from apes, then the question would naturally arise:

why apes? What was so special about apes that led at least one of them to evolve into an intelligent being like us? The answers to these questions are not difficult to find. If we look at the animal kingdom we can clearly notice that the apes—the chimpanzee, gorilla, orangutan, and the like—clearly stand apart. In many ways these tail-less forest-dwellers show an uncanny resemblance with humans, not only in physical appearance but in some aspects of behaviour too.

Before trying to find out their similarities with humans, let us first examine what made the apes adapt to a life in the branches of forest trees. The first and foremost requirement for a life among the branches, obviously, is an ability to hold on to a branch by grasping it, and this requires hands with fingers and nails and opposable thumbs rather than claws. The opposable thumbs also enable the tree-dwelling apes to pick up and hold small food items such as nuts and berries using the forefinger and the thumb.

Another vital requirement for a tree-dweller is the ability to correctly judge the distance of a branch in front before jumping on to it. This requires perception of depth possible only with stereoscopic vision which could be provided only by a pair of eyes set at the front of the head—another characteristic feature of ape anatomy. Tree-dwellers also need the ability to sit and stand upright so that their front limbs could be used for grasping, picking and manipulating food, and doing other tasks.

Unlike most other mammals, the apes also possess a well-developed colour vision which is a great advantage in forest living, for it helps them distinguish fruits, berries and other edibles and also in some kind of visual communication.

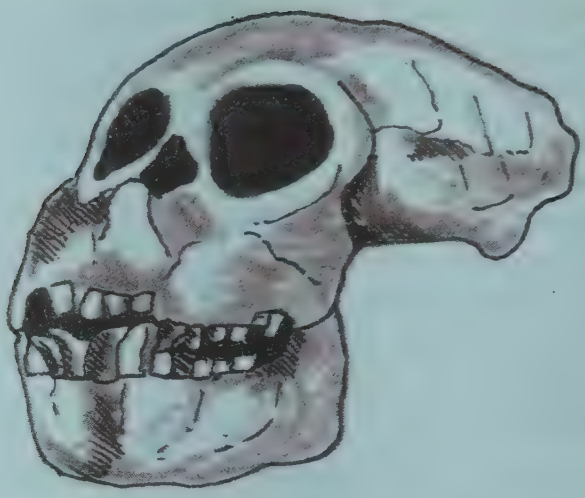
To cap it all, to be able to do all this, the tree-dwelling ape needed an efficient brain to process the available information—from the finger-tips grasping a branch, from eyes judging the distance of a far away branch, and the like.

Long time in the past the apes already had a well-developed brain and it would be the increase in the brain size and consequent enhancement of its capabilities that would ultimately decide the course of the ape's evolution into the modern human being.

Despite the many similarities with humans in physical features the apes are different from us in one very important characteristic—they cannot speak as we humans do. Most animals, even the apes, communicate with each other either through scents called *pheromones*, facial expressions, or through a few vocal sounds such as grunts or screams, which serve their basic needs for survival quite well. But they are grossly inadequate for communicating ideas and thoughts the way we humans do. It is now believed that the ability to utter words for communicating specific meanings was acquired by human ancestors much later after the early human-like creatures appeared about 6 million years ago, and it was this capability of articulated speech that set the path for the appearance of modern humans.

But before tracing the tortuous path to humanhood, let us see when the first apes appeared. Years of painstaking search by fossil hunters around the world has now established that the apes appeared around 30 million years ago. The oldest fossil remnant which scientists have positively identified as belonging to an ape is a skull about 28 million-years old. It was found in the desert at a place called Fayum, south of the city of Cairo in Egypt.

Near the site where the ape skull was found, scientists also found fossil plants and fruits typical of early tropical rain-forests, indicating that the site was in the midst of lush green forests 30 to 40 million years ago. The first apes, which scientists have named *Aegyptopithecus* (from its location in Egypt and the Greek *pithecus*, meaning 'ape'), lived in this tropical rain-forest surviving on wild fruits and berries. The first ape, as reconstructed from fossil bones found at Fayum, was a small animal, no bigger than a cat or a small dog. But size was of no consequence, for it was

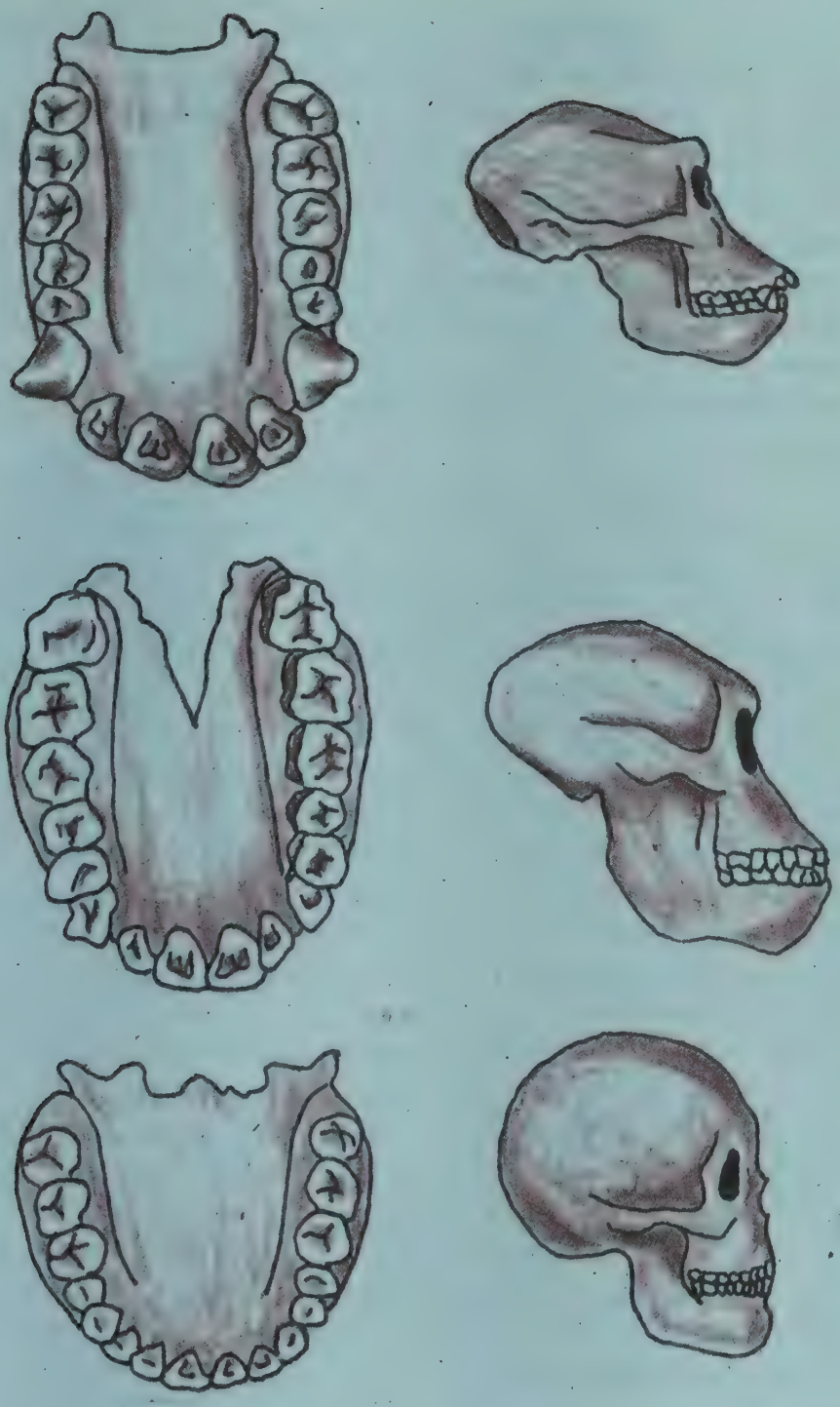


Aegyptopithecus skull discovered at Fayum, Egypt

"the oldest creature we know that is in the direct ancestry of man." We can see the descendants of *Aegyptopithecus* in the form of the present-day African chimpanzee and gorilla, and the Asian gibbon and orangutan. None of these could possibly get over its 'apehood' and set out to become modern man.

There have been several reports of the discovery of fossils claimed to be of man's 'true ancestors' from time to time. They include two, named *Proconsul* and *Kenyapithecus*, from Kenya; two, named *Ramapithecus* and *Sivapithecus*, from locations in India, Pakistan, China and Kenya; and two, named *Dryopithecus* and *Rudapithecus*, from Europe. These ape-like creatures lived at various times between about 8 and 20 million years ago. Of these the one that created a sensation and which was once regarded as man's oldest direct ancestor was *Ramapithecus* (named after Lord Rama, the exiled prince in the epic *Ramayana*), fossils of the upper jaw of which were first found in the Siwalik Hills in India.

It is possible to tell whether a tooth or jaw belongs to an ape or a human-like creature from their shape and other characteristics which differ greatly between apes and

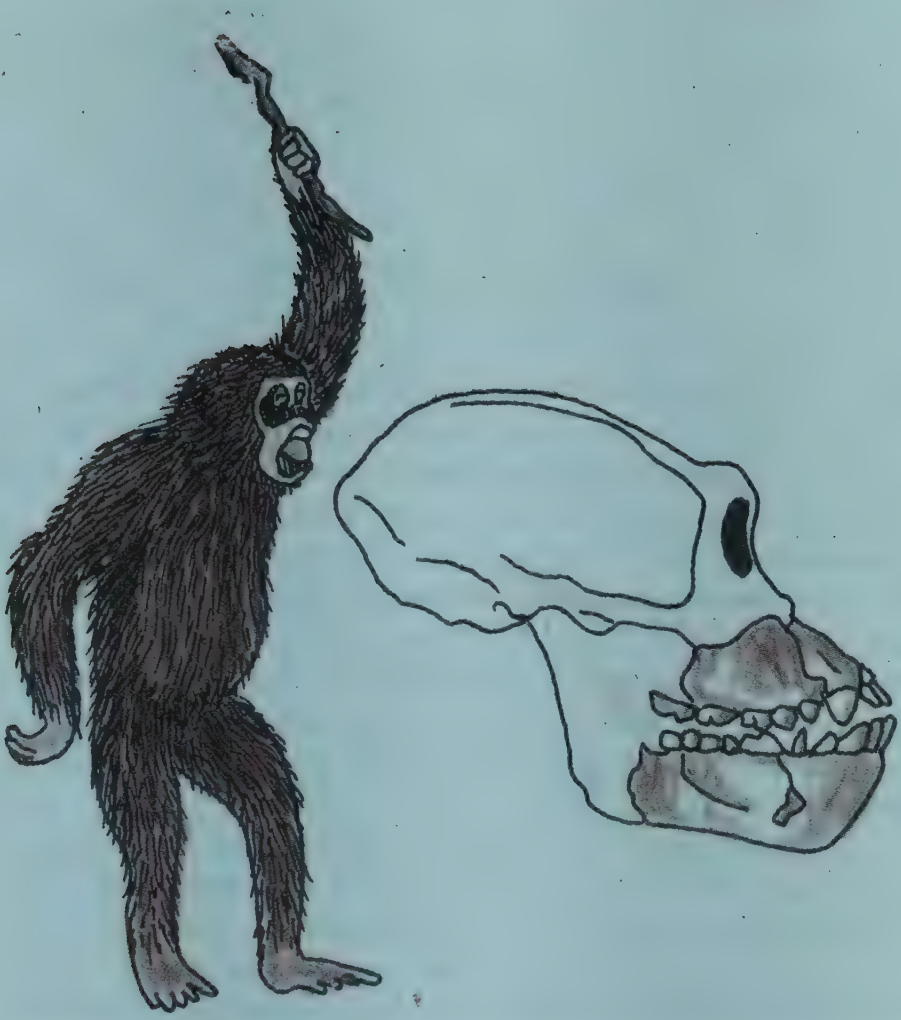


Ape and human jaws: ape's jaw is U-shaped and has large canines while human jaw is arched with almost imperceptible canines

humans. A typical ape jaw, for example, is shaped like an 'U' while a human jaw is smaller and arch-shaped. In an ape, the jaw projects forward, the canine teeth are large, and there is a gap between the upper canine and incisor. In humans or their close ancestors, the jaw does not project forward, the canines are small and there is no gap between the upper canine and incisor. Besides, the molars in apes are larger than human molars. Thus, by carefully looking at a fossil jaw or a few teeth, scientists can tell whether they belong to an ape-like creature or a human-like creature.

In 1910, the English palaeontologist Guy Pilgrim, working with the Geological Survey of India, discovered two parts of a lower jaw in the Siwalik Hills. He did not realise the significance of the discovery at that time. The first scientist to recognise the importance of Pilgrim's find was a young Yale student, named G. Edward Lewis, who in 1932 discovered an upper jaw of *Ramapithecus*, while digging at a place called Haritalya Nagar, a cluster of villages near Chandigarh. He claimed it was a common ancestor of modern man. The fossil had some human-like features and was 14 million years old. Similar fossils were later discovered in China, and east Africa. From the study of DNA of apes and humans, scientists now believe that we share a common ancestor with apes that lived about 10 million years ago—and that ancestor most probably was *Ramapithecus*. But in the mid 1970s the support for *Ramapithecus* began to wane, when Donald Johanson's discovery of *Australopithecus afarensis* showed that the hominid family most likely arose in Africa, not in Asia.

The final blow came in 1979, when David Pilbeam of Yale University, who was also working in the Siwalik Hills, discovered a complete skull of a closely related ape species which had decidedly orangutan-like features. Soon it became clear that most, if not all, of the hominid characteristics of *Ramapithecus* were actually the result of 'reconstructive wishful thinking' rather than hard fossil evidence.



Ramapithecus (*left*) and skull reconstructed from jaw fragments (*right*)

Ramapithecus was, after all, just another ape, a member of a group related to the orangutan. As we know today, the ape-like creature of which we can claim to be direct descendants came much later—about 3 million years ago. This creature appeared after spells of climatic upheavals that swept through the world around that time and made the tree-dwellers come out in the open. It was indeed a question of life and death and those among the apes that could adapt to the changing environment came out winners. It was one of the successors of these plains-dwellers who would ultimately become our forefathers.

2

APES THAT WALKED

The early apes that lived in the lush tropical forests of North Africa already had some attributes not found in other mammals. They possessed good three-dimensional vision and excellent muscular coordination essential for a tree-dwelling life. With these attributes, the early apes lived an easy life spending most of their time leaping and swinging on the trees. Their food comprised mainly of fruits, berries and nuts, and occasionally small animals available in plenty in the forest habitat. They rarely had to face any competition from ground-dwelling animals—the grazers and the carnivores.

But, between 5 and 6 million years ago, a catastrophic environmental change—a sharp fall in temperature—occurred that ended the peaceful life of many forest-dwellers including the early apes. They were confronted with a different kind of adversary—a sharp climatic change that led to rapid disappearance of the forests that were their only abode. It was this challenge that ultimately decided the fate of the tree-dwelling apes, forcing some of them to adapt to a life on ground and walk on two feet that would finally lead them towards humanhood.

Evidence of the profound global cooling that brought about large-scale disappearance of forests comes from the analysis of deep-sea cores and terrestrial deposits of fossil pollens, and other geological records. According to one scenario, the drastic plunge in temperature—some believe by as much as 11°C—produced a rapid build up of ice in Antarctica. This led to the locking up of so much water in

the polar ice sheets that sea levels worldwide dropped by 50 to 60 m. At the same time, the climate became so dry that rainfall was severely affected and in many places, especially in tropical Africa, lush forests gave way to open grasslands. As the forests disappeared the habitats of early apes shrank alarmingly, threatening their very survival.

It was around this time, that competition for space and food forced the early apes to split into groups that remained in the forests and others who had to leave their arboreal abode and try to adapt to a life in open grassland. Maybe, among the displaced groups, those more adept at an upright posture fared better, ultimately paving the way for bipedalism (walking on two feet), a hallmark of humanness. It is quite possible that the emergence of other human-like features, such as a flatter face, more level teeth and larger brain size also came about during the period the early apes were trying to come to terms with a more demanding and hostile life on the ground. They learned to walk upright, were forced to eat almost anything that came to hand, and learned the value of sharing their food with others—typical human traits.

But we must admit that these are only intelligent guesses. There is a big gap in fossil records for a period of almost 26 million years (except the *Ramapithecus* and a few other ape-like creatures) that could throw light on the developments that led to the appearance of the early human-like creatures from the earliest ape *Aegyptopithecus*.

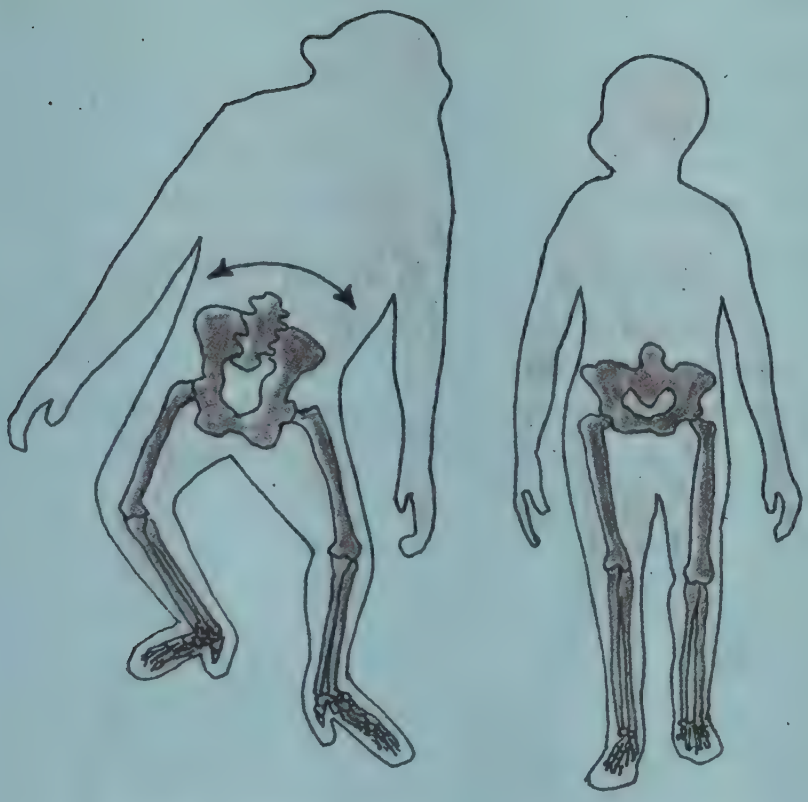
Fossil remains of one of our earliest ancestors were discovered in the mid 1970s at Hadar in Ethiopia and at Laetoli in Tanzania. Among them was a remarkable 3.2 million-year-old skeleton, though incomplete, of an individual—an adult female—who came to be known as 'Lucy'.

The discovery of Lucy came about almost by accident. In November 1974, anthropologist Donald Johanson and his team were looking for fossils of human ancestors at a place called Hadar in the Afar region of Ethiopia. They had

almost given up, as the only fossils that came up belonged to animals—no fossils of ape or human ancestors. Then, one day, as the men were preparing to return to camp, Johanson spotted a piece of long bone that looked like a piece of an arm. Then, in quick succession, more pieces were unearthed—part of a skull, a bit of thigh bone, pieces of vertebrae and some ribs, a part of a pelvis, a couple of pieces of jaw—the place suddenly appeared to sprout fossils. During the next few days, several hundred more pieces of bone were recovered. When, finally, the pieces were painstakingly matched together, they turned out to belong to a single individual—an adult female. From the fossil remains, Lucy appeared to be rather short, a little more than a metre tall, weighing about 30 kg and capable of walking on two feet. Scientists named this human ancestor *Australopithecus afarensis*—the name *Australopithecus* literally meaning the 'southern ape', and *afarensis* from the Afar region where the fossils were found.

For scientists trying to probe the origins of the human race, Lucy was a remarkable find on several counts. She was the most complete and the oldest ancestor of modern man known up to that time. Moreover, the discovery of a part of the pelvis and the thigh bone helped establish beyond doubt that Lucy walked upright. The angle of Lucy's thigh bone is such that it brought her legs under the body, enabling her to walk on two feet without swinging from side to side, as apes do. Another notable feature was the alignment of the big toe on Lucy's foot with the other fingers—a characteristic of the human foot.

A corroboration of the fact that Lucy, or *Australopithecus afarensis* in general, did indeed walk on two feet came from the discovery in 1978 of fossil footprints of similar creatures at Laetoli in Tanzania. The most significant find at Laetoli were several footprint trails initially discovered by palaeoanthropologist Andrew Hill working with Mary Leakey, wife of the British anthropologist Louis S.B. Leakey. One of the trails, made of footprints of a pair of individuals



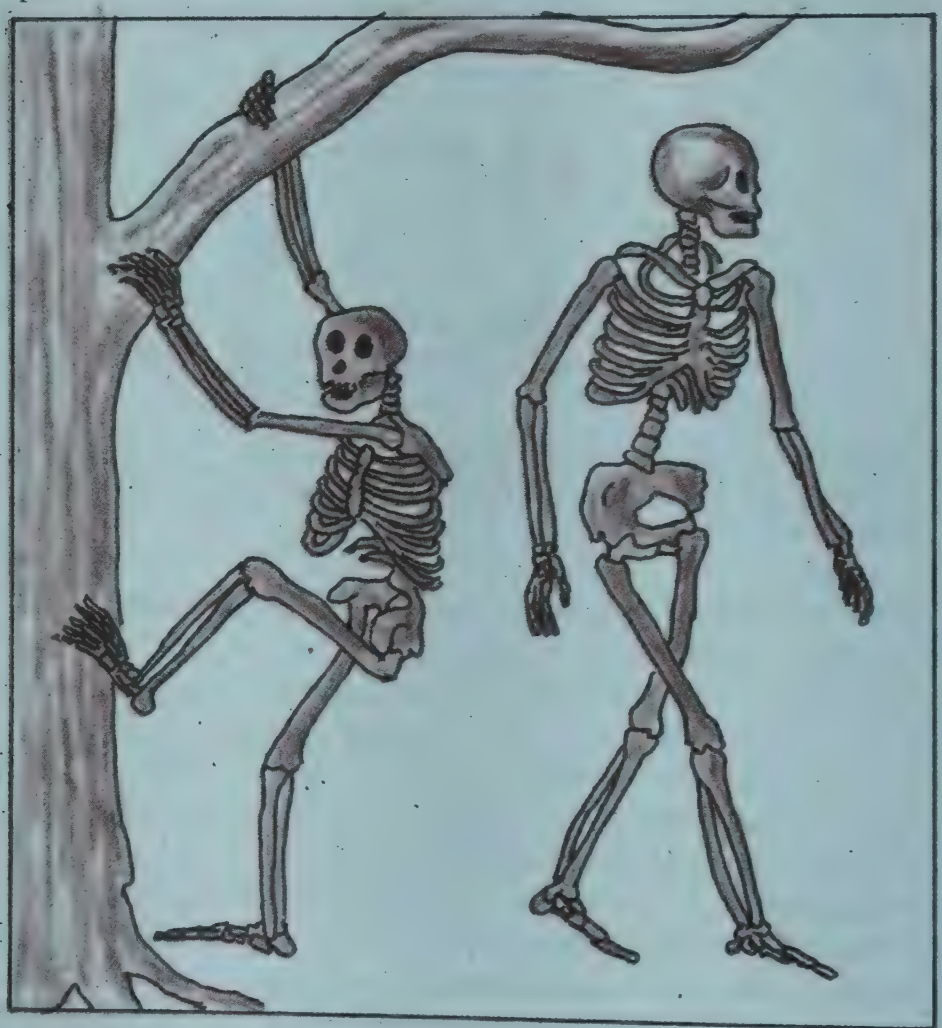
Thigh bones of a human (*right*) are designed for walking upright while an ape's thigh bones make the animal swing from side to side while walking on two feet

who had walked side by side, was preserved over a total distance of about 48 m. The footprints, made on wet volcanic ash 3.7 million years ago, later hardened and got buried under more ash. They looked almost like the footprints of modern humans, with the typical 'arch' clearly visible, and the toe pointing forward, quite unlike an ape's.

Later discoveries of similar fossil remains in Ethiopia and elsewhere provided the scientists with enough material to draw up a rough description of the newly discovered species. From their studies we know that the females of *Australopithecus afarensis*, like Lucy, were substantially smaller than males—a condition similar to that seen in modern African apes. The males were almost twice the size

of females. They had rather small heads and large teeth. The brain size (volume) of an *Australopithecus afarensis* male was only about 400 ml, compared with an average of about 1,350 ml for modern man. Obviously, the brain of Lucy and her kins was too small to have the capability of articulate speech; they could not have made use of a spoken language like us.

A detailed analysis of the shapes of the shoulders, the trunk and limbs of Lucy revealed that although she and her species did walk on two feet, they probably could not run



Australopithecus afarensis (left) could walk on two feet like humans *(right)* but it was more adept at climbing trees

like we humans do. But they were quite adept at climbing trees. Thus, while *Australopithecus afarensis* had many attributes which made them humanlike, in all probability they were more apelike in looks and physical features, and were only slightly smarter than the average ape.

A year after the discovery of Lucy, in 1975, a remarkable trove of early human fossils came to light at Hadar. The site produced fragmentary remains of 13 individuals of all ages—male and female, adult and juvenile. The fossil remains, found all jumbled up next to one another, could well have belonged to the same family, and the find soon came to be known as the 'First Family'. How so many individuals came to be buried together can only be conjectured. Most probably it was some natural catastrophe, may be they were caught together in a flash flood. This was the earliest evidence that man's earliest ancestors congregated in groups.

Although Lucy was a remarkable find, she was faceless. The remains of *afarensis* found at Hadar did not include any complete skull which usually shows up best the differences between the ancestors of humans. The first almost complete skull of an *afarensis* was unearthed by Donald Johanson's team at Hadar in 1992. At first, the pieces of the skull and other bones that came up at the site seemed to belong to some other species—they were much bigger than the bones of Lucy. But closer examination showed them to be identical with those of Lucy, only bigger. The skull was no doubt that of a male *afarensis*. Such a difference in size between males and females of the same species is quite common in apes. From the size of the skull and bones it appears that the thickly muscled male *afarensis* must have stood at around 1.5 m, at least 30 cm taller and two-thirds heavier than *afarensis* females.

From whatever we know so far from fossil records, we can tell with certainty that Lucy and her kind adapted well to the scant forests of juniper and olive trees that dotted the landscape at Hadar 3 million years ago. Still, Lucy and her

kind had to survive in a diverse assortment of habitats. They probably scavenged meat from carnivores and caught small prey to supplement a diet of fruits, nuts, roots, tubers and other vegetation. They may have used stone tools, but that would have been exceedingly primitive.

It may at first sight, appear unlikely that *afarensis* males, with their rudimentary stone tools could at all compete with wild predators such as the cheetah and scavengers like the hyena and the omnipresent vultures in the African savannah. But recent studies have shown that even after the predators and scavengers are through with a kill, the carcass of a deer, for example, is left with enough bones containing nutritious marrow inside to provide a rich meal for two adults. With their primitive tools Lucy's kin could have easily cracked open the bones to get at the marrow inside. It has also been conjectured that *Australopit ecus afarensis* had enough intelligence to exploit the feeding habits of predators like the cheetahs which usually stash away their kill high up on trees, out of the reach of scavengers. Knowledge of such habit would have allowed *afarensis* to occasionally steal the kill for a sumptuous feast.

Being able to walk on two feet, *Australopithecus afarensis* had literally taken the 'first step' to humanhood, for it is now believed that the increase in brain size that ultimately led to the appearance of our species around 100,000 years ago, came later. It was only after the 'hands' became free for complex tasks such as tool making, that the need for a better, more capable brain arose.

The ability to stand and walk on two feet offers many advantages for a life on the plains. For example, it enables the individual to have a much better view of the surroundings and to get advance warning of predators. It also makes it easier to find food. Besides, the now freed 'hands' made it possible to collect the food and carry it to another place—to the family group to share, perhaps. It also makes possible the use of 'tools' and 'weapons' which would be a

tremendous advantage. Recently some anthropologists have suggested that an upright posture may have also helped our distant ancestors to evade the scorching sun of the tropical grasslands as it exposes much less of the body to the sun than a four-legged posture.

So it was around 4 million years ago, that the earliest human ancestors broke away from a life on the branches of forest trees, compelled by environmental upheavals, and started on a different kind of life on the plains. Those with an ability to walk on two feet had tremendous advantages over others in the new disposition and it was their successors who survived, developed more skills and carried on the march towards humanhood. *Australopithecus afarensis* survived for about 1 million years before disappearing from the fossil records about 2.8 million years ago.

Till 1994, Lucy and her kind were considered to be the oldest human ancestors to have walked on two feet. But a new fossil find made by Meave Leakey, wife of Richard Leakey (son of Louis S.B. Leakey), and her team at a site called Kanapoi near Lake Turkana in Kenya changed this theory. Fragments of a 4.1 million-year-old jaw and leg bones were recovered from the site. The shape of the teeth showed that it belonged to a creature more humanlike than apelike while shape of the leg bones clearly pointed to an animal walking on two feet. The new, older species has been named *Australopithecus anamensis.*

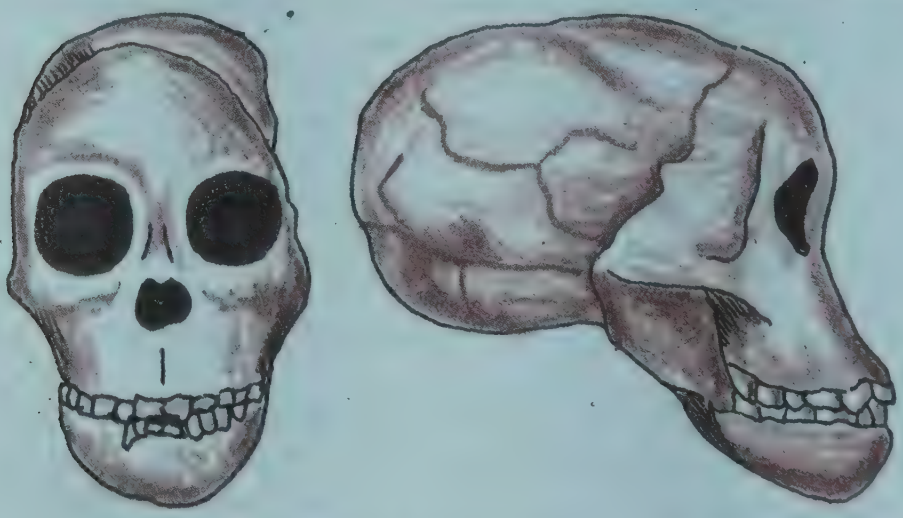
Fossils of yet another, still older, human ancestor that walked on two feet were discovered in 1994 at a site called Aramis in Ethiopia by an international team led by University of California palaeoanthropologist Tim White. Dated at 4.4 million years, this species has been named *Aridipithecus ramidus—ramidus* meaning 'root' in the Afar language.

Although Lucy and her kind walked on two legs, they were still far from becoming humans. They were more like midway between true apes and modern humans. For example, Lucy's arms in relation to her legs were longer than

ours, but not as long as an ape's. It is now believed that while *Australopithecus afarensis* may have been the oldest ancestors of modern humans, a true human species did not appear on the scene till about 2 million years ago. In the intervening period three other *Australopithecus* species appeared on the scene; the fossil remains of all the three have been discovered.

Years before Lucy was discovered, a remarkable fossil—part of a skull of an ape-like creature—was unearthed from a limestone quarry at Taung in South Africa in 1924. Its discoverer Raymond Dart, head of the Anatomy Department at Wilwatersrand in South Africa, was quick to notice several features in the fossil which he thought were human-like. He published his finds in a paper in the British science journal, *Nature* in February 1925, in which he suggested it to be that of an early human ancestor which walked upright. He called it *Australopithecus africanus*, or 'southern ape of Africa'. Since the fossil skull was that of a child, it became better known as the 'Taung child'.

Before 1925, all fossil records of human ancestors came from Europe and Asia—mainly Neandertal man and *Homo erectus* (known then as *Pithecanthropus*). Africa was considered by most experts to have had little or nothing important



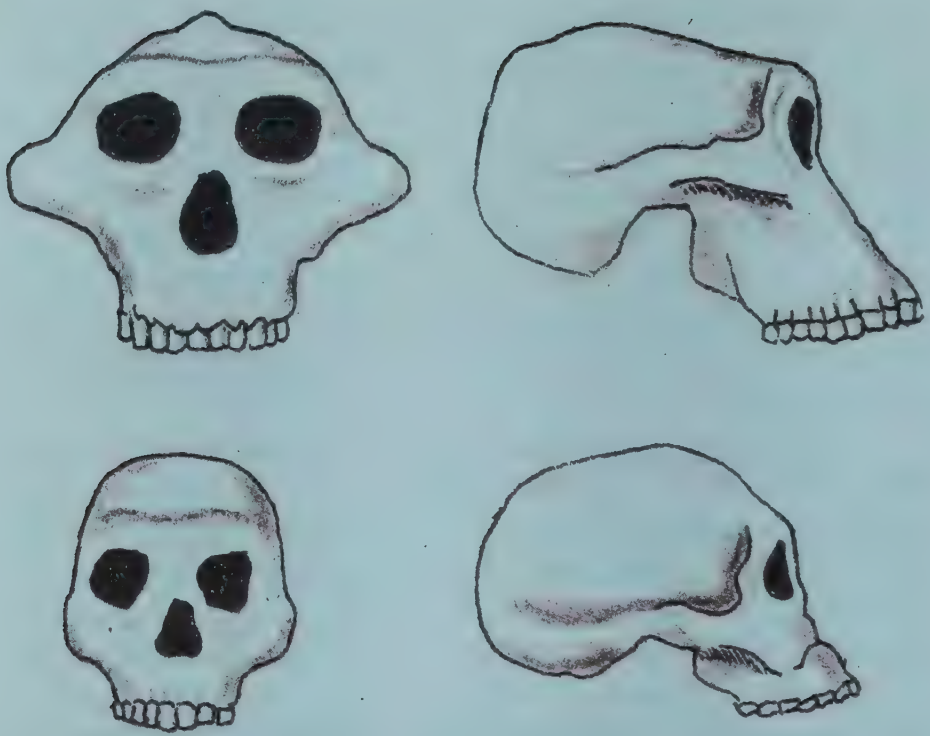
Skull of the 'Taung child' found at Taung in South Africa

to do with human origins. So the report of Dart's discovery of the Taung child was initially received with scepticism. But, finally, it was accepted as a legitimate member of man's ancestry. The 'Taung child' skull was the first fossil of early human ancestor to have been found in Africa.

The Taung child skull was probably not older than 1 million years, but similar fossils from two other cave sites in South Africa indicate that *Australopithecus africanus* may have dominated the scene from perhaps 3 million to 2 million years.

Although the *Australopithecus africanus* had a more human-like structure of teeth and certain aspects of the brain structure, compared with *Australopithecus afarensis*, it showed only slight differences in body size or shape. For example, the *africanus* was not much bigger than the *afarensis*, although the brain size of 440 ml was slightly larger. But it was still too small and less developed to endow its owner with the ability to speak. The back teeth of the *africanus* were a little bigger and the front teeth a bit smaller.

Discovery of the fossils of a third species of *Australopithecus* came about by sheer chance. In 1938, Scottish physician and palaeontologist Robert Broom was collecting specimens of fossils thrown up during excavation of limestone quarries at Sterkfontein, near Johannesburg in South Africa when he chanced upon a part of an upper jaw with one molar tooth still attached to it. The rest of it came from a schoolboy who brought out from his hiding place in the hills nearby four teeth and a lower jaw with two teeth in position. Together, the pieces revealed a skull that was distinctly different from that of the *africanus*. The new face was more massive and flat and had relatively small front teeth, but its grinding teeth were massive, set into a thick and heavy lower jaw. Keeping in view its robust appearance, the new species was named *Australopithecus robustus*. The new species, it is presumed, was of a much stronger built than the *africanus*, standing almost 1.2 m tall, and lived



The massive and flat skull of *Australopithecus robustus* (*top*) compared to that of the *Australopithecus africanus* (*bottom*)

on mostly coarse, tough food that needed much chewing, such as nuts, hard-shelled fruits, fibrous roots, and tubers. Its brain size was around 530 ml—larger than that of the *africanus*.

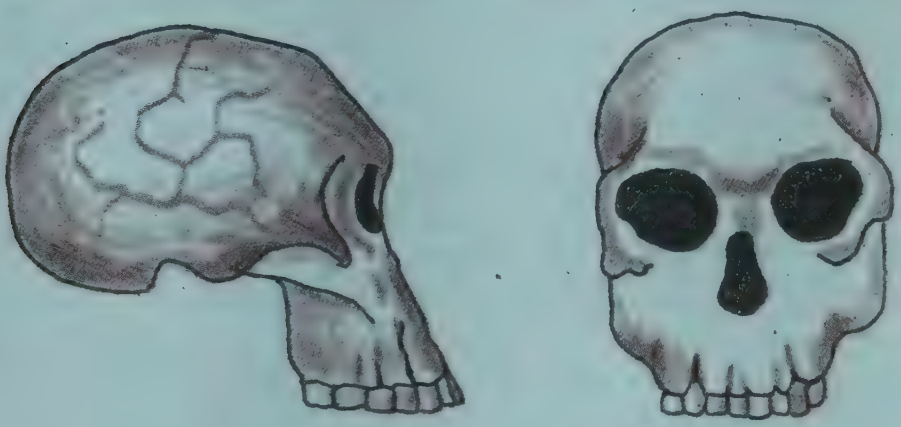
Excavations around Sterkfontein have unearthed not only some 130 individuals of the *robustus* species but also bone tools, which show that bone tools were in use long before the advent of stone tools. Fossil records tell us that the *robustus* appeared some 2 million years ago and died out about 1.5 million years ago.

More than 20 years after the discovery of *robustus* fossils in South Africa, fossils of a similar creature turned up in east Africa. In July 1959, Mary Leakey spotted two huge teeth and a piece of a skull while digging at a site in the Olduvai Gorge in northern Tanzania. Subsequent excavations at the site brought forth more than 400

fragments of bones. When the pieces were matched together what appeared was an adult skull, quite similar to the ones unearthed at Sterkfontein in South Africa in 1938. But there were differences: the new specimen had a more massive jaw and bigger grinding teeth than the earlier find. Louis Leakey thought it belonged to a new genus and coined a new name for it—he called it *Zinzanthropus boisei.* Today, however, it is known by the name *Australopithecus boisei* (after Charles Boise who financed many of Leakey's expeditions to search for early man).

Australopithecus boisei not only had more massive jaws and bigger grinding teeth than *Australopithecus robustus,* it was also taller, standing at about 1.5 m. But its brain capacity was the same—about 530 ml. It is now accepted that *Australopithecus robustus* of South Africa and *Australopithecus boisei* of east Africa are geographical variants—the differences in their body structure was due to their being natives of two widely different geographical locations.

The remains of *Australopithecus boisei* are relatively scarce. Only one skull, a fragment of thigh bone and a few teeth have been recovered from the Olduvai site dated to be about 1.8 million-years old. Another skull was discovered near Lake Turkana in Kenya in 1969.



Homo habilis skull has a larger brain capacity than its predecessor *Australopithecus africanus*

It was now increasingly becoming clear that around two million years ago, three different types of human ancestors—*Australopithecus africanus, Australopithecus robustus* and *Australopithecus boisei* inhabited the earth, living mostly near lake shores or river banks. Some anthropologists believe that some stray populations of *Ramapithecus* may also have been around. These species showed progressive increase in brain size and other physical changes that made them appear more humanlike. But only one of them—*Australopithecus africanus* is believed to have ultimately evolved into the larger-brained creature which has been named *Homo habilis*; the first of the true human-like ancestors of modern man.

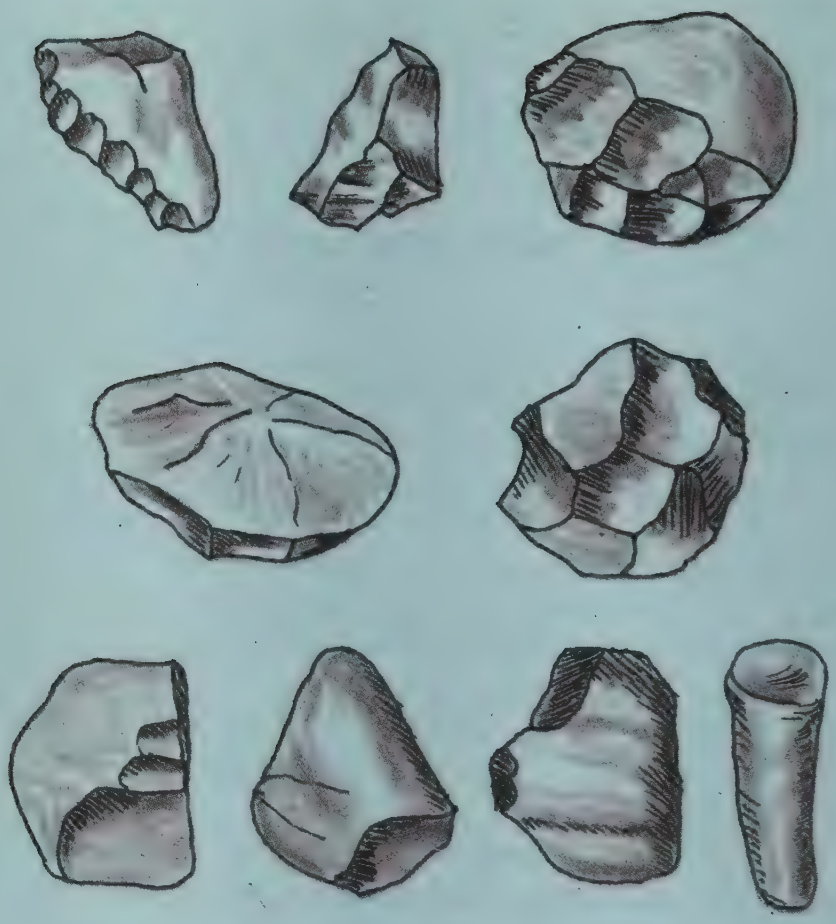
3

THE FIRST TOOL-MAKERS

Olduvai Gorge is a deep gash running between the volcanic highlands and the Serengeti Plains of east Africa. One lakeside plant that is spectacular less for its flowers than for its medicinal properties is *Sansaveria*, a succulent that has the local name of Olduvai after which the gorge is named. The landscape at Olduvai today is in many ways similar to that seen by early man a couple of million years ago. The only difference is that in early times a lake occupied what is now the central part of the gorge. It is here among exposed layers of clay and volcanic ash that remains of *Homo habilis*, the first true member of the human family, were discovered.

The first fragments of *Homo habilis* fossils were unearthed by the British palaeoanthropologist and son of Louis S.B. Leakey, Richard Leakey and his team around 1960, about the same time that *boisei* fossils came up. But at that time they didn't really provide any clue to the creature they belonged to. It was only in April 1964 that it was announced that the 1.8 million-year-old fragments belonged to a new genus with features resembling humans more than apes. At the suggestion of Raymond Dart it was named *Homo habilis*, or 'handy man'. The name was quite appropriate as a large collection of primitive stone tools were also recovered at the same site, indicating that *Homo habilis* was indeed quite adept at making tools.

Although the original *habilis* fossils were discovered at Olduvai in Tanzania, the best specimens were unearthed later at Koobi Fora on the shores of Lake Turkana in Kenya.



Stone tools used by *Homo habilis*

There, in 1972, Richard Leakey's team recovered the most complete skull of *Homo habilis* ever found, along with thousands of fossils of other animals, and stone tools.

Even a casual look at the *habilis* skull found at Koobi Fora was enough to convince anyone that it was more humanlike than apelike. The face of *Homo habilis* was flatter than that of any of the *Australopithecus* species and its brain size was significantly larger—680 ml—although still only half as large as the average human brain today. So *Homo habilis* must have been more intelligent than any of the earlier ape-like ancestors of man. But what is more significant is that the *habilis* brain was not only bigger but also

more complex than the brain of any of the *Australopithecus* species.

From the shape of the skull and the marks on its inner surface, brain specialists have identified a specific area in the *habilis* brain similar to what is known as Broca's area in the human brain, which is essential for speech. This means that, although *Homo habilis* had a brain only half as big as the human brain, it probably had the capability of uttering a few simple 'words', but not much.

From fossil studies it also became clear that it was not the brain size alone that came in the way of the earliest human ancestors from becoming good orators—they didn't even have a suitable voice-producing organ needed for articulate speech. The voice box, or larynx, of *Homo habilis* was located too high up in the throat, leaving very little space in the pharynx (*see* Chap. 6). In contrast, our species have a larynx placed quite low in the throat which makes a much larger space available in the pharynx and thus facilitating a much wider range of sound production.

Nevertheless, in the tortuous path towards attaining humanhood, the appearance of *Homo habilis* marked a quantum jump in the human evolution process. *Australopithecus robustus* and *Australopithecus boisei* which came before it were more apelike, living an exceedingly primitive life, without articulate speech, with poor tools and weapons and probably surviving on a meatless diet. In contrast, *Homo habilis* had a much increased brain power, which heralded not only the beginnings of speech, but also the all important advantage of stone tools.

From the kind of stone tools found at *habilis* sites, one thing became clear: *Homo habilis* was intelligent enough to gather the right kind of stone for making tools from places as far as 10 to 15 km away and then shape them carefully into various forms. From the way the tools were shaped by hand by flaking, one can tell that the first human-like tool-makers were right handed. They were possibly our earliest ancestors known to eat meat. The fossil sites also

give an impression of group activity and some sort of social organisation. Some scientists even conjecture that *Homo habilis* saw the beginnings of ritual and folklore—typical human endeavours.

From a sampling of stone tools recovered from *habilis* sites, it appears that the tools were quite useful. Small sharp-edged flakes chipped off larger stones formed tools for cutting the meat from bones of dead animals. Using similar primitive stone tools scientists have actually been able to not only skin a dead elephant but even cut chunks of meat from it. That such stones were actually used for cutting meat is evident from the fine cut marks seen on fossil animal bone fragments unearthed at *habilis* sites. The number of animal bones on the living sites demonstrates that *Homo habilis* not only hunted, but did so successfully. We do not have any direct evidence to tell us what methods *Homo habilis* may have used for hunting; they probably clubbed and speared their victims to death.

The pattern of accumulation of these remains suggest that our early ancestors brought dead animals and tools to a common spot where meat was butchered. But it is unlikely that they actually hunted large animals for food; their tools were too primitive for that.

On the basis of the fossil finds at Olduvai and Koobi Fora, we can build up a possible scenario in which *Homo habilis* lived. The daily life at Olduvai represents a crucial juncture in human evolution. These earliest ancestors of ours shared the land with rich fauna—antelopes, pigs, birds, tigers and elephants which flourished in the salubrious climate of 1.85 million years ago, which was far cooler and wetter than today's parched plains. Like all primates, *Homo habilis* subsisted mainly on a diet of plant parts such as fruits and berries and also roots and tubers which they dug up using pointed bones or stone tools. In addition, the diet also included raw meat which they probably scavanged from the kills of other carnivores.

Although they were more enterprising than the earlier

apes, *Homo Habilis* in all probability made their homes in the trees to escape from carnivores. We know this from their skeletal remains: they reveal that *Homo habilis* had long arms well adapted to tree climbing.

From the study of fossil remains, other interesting facts about *Homo habilis* have come to light. Patterns of tooth growth indicate that the family life at Olduvai was more like that of apes than of humans. They indicate that *habilis* children grew up nearly twice as fast as children of modern humans. This would also mean that our early ancestors would have been young adults by age 12, parents in their teens, and become old by the time they turned 30.

An interesting thing about the fossil finds at Olduvai and Koobi Fora is that all the sites where fossil remains of *Homo habilis* have been located are also the sites which have yielded fossil fragments of *Australopithecus boisei*. The age of the fossils are also around the same. This obviously means that *Australopithecus boisei* lived at the same time and possibly in the same terrain as *Homo habilis* did. But we have no clue as to how the two coped with each other or whether they competed for food, which seems unlikely. *Homo habilis* with much greater brain power and stone tools must have had a wider choice of food than the more primitive *Australopithecus boisei*. No wonder, it would be the more advanced *Homo habilis* that would now be on the direct road to humanhood, leaving the others by the wayside.

It is now an accepted fact that the appearance of *Homo habilis* was the turning point in human evolution; it marked a major milestone in the march of the lowly ape towards humanhood. How did it come about? Most probably it was brought about by a sharp environmental change of the kind that had earlier provided the stimulus to primitive apes to come out of the forest and adapt to a life on ground. That this may really have been the cause is borne out by climatic data. Records show that after the global freeze about 6 million years ago the climate had warmed up again. But, around 2.5 million years ago temperatures dropped again

bringing in a little of Ice Age.

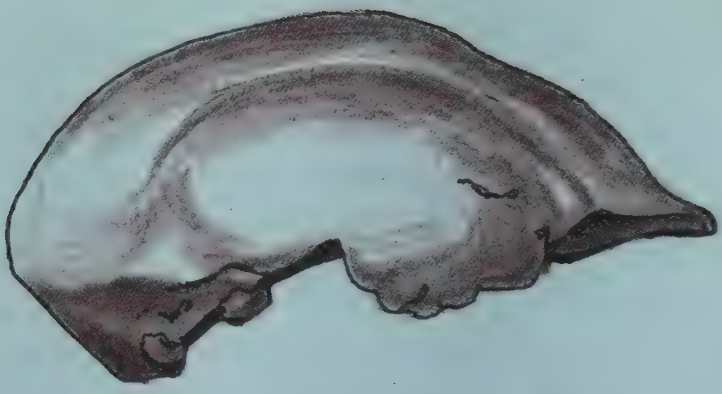
It was during this period, it is now believed, that the early ancestors of man split into two diverging branches—one branch leading to *Australopithecus robustus* and the other—*Homo habilis*—to direct modern humans. The discovery of the oldest *Homo* fossil was reported in 1996. The 2.3 million-year old fossil jaw was found at Hadar in Ethiopia in 1994 near a dry stream bed by a team led by William Kimbel of the Institute of Human Origins in Berkeley, California, USA. By the time *Homo habilis* died out some 1.5 million years ago, a new, more advanced human ancestor had appeared on the scene. Named *Homo erectus*, or the 'upright man', this large-brained ancestor of ours was a true wanderer. It would become the first early human to leave the cradle of the African continent and spread around the world.

4

EXPANDING HORIZONS

In the last decade of the nineteenth century an unusual fossil discovery was made in the island of Java in Southeast Asia, that would turn out to be a landmark in our search for human origin. The discovery was made by Dutch anatomist Eugene Dubois, who in the late 1880s developed a passion for finding the true human ancestor, the 'missing link' between apes and modern man. At that time, only about half a dozen discoveries of fossil man were known but nothing that could be considered as the missing link. Dubois was inspired by the writings of German zoologist Ernst Haeckel, who was a strong supporter of Darwin's ideas. Haeckel reasoned that since humans and apes are closely related, then, if humans have indeed evolved from apes, there must have been some kind of an intermediate link between them. He had even given a name for that intermediate form. He called it *Pithecanthropus*, meaning 'ape-like man'. He even suggested where remains of such a creature would be found—in the 'bone caves' of the Malay archipelago. In 1887, Dubois sailed for the Dutch East India with the avowed intention of finding remains of fossil ape-man.

In 1889, two years after arriving in Java, Dubois set out on his search. With 50 convict labourers he started excavation along the Solo river. In 1891, two key fossils turned up near the village of Trinil—a tooth and a skull cap. The next year, a modern-looking thigh bone was found which clearly did not belong to an ape. The fossils were dated at about 1 million years. Realising that the skull cap certainly

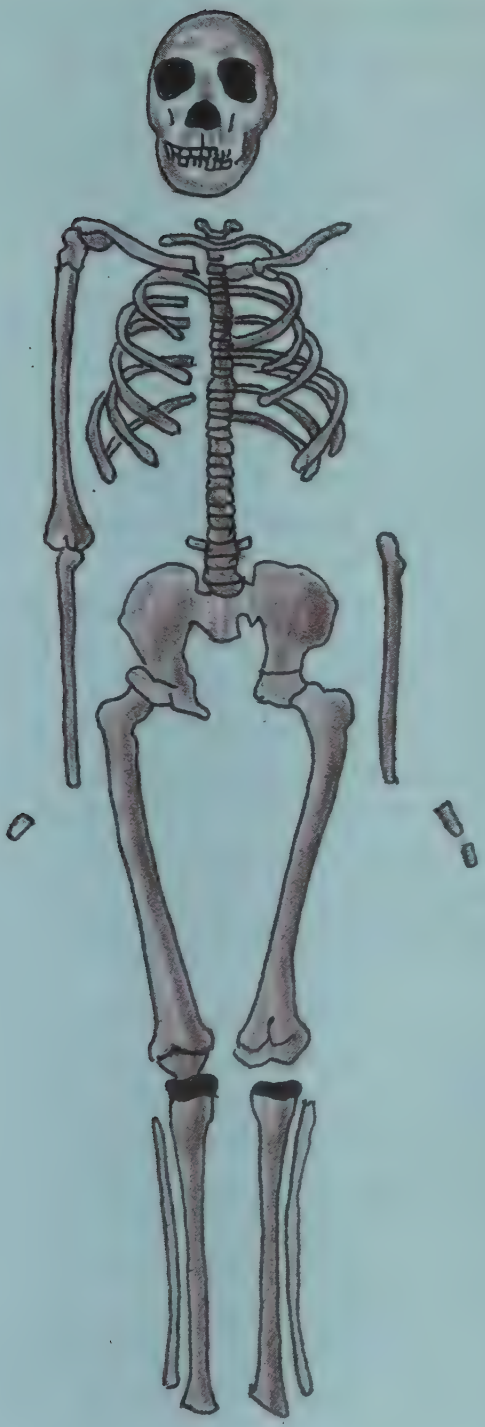


Skull cap of *Pithecanthropus*, the 'ape-like man' discovered by Eugene Dubois in Java

belonged to a creature with a large brain, and convinced that the tooth, skull cap and thigh bone came from the same individual, Dubois was sure he had stumbled upon the fossil remains of Haeckel's missing link. He called the creature *Pithecanthropus erectus*, because from the shape of its thigh bone there was no doubt that this ape-like man walked upright. To the public it would be known as 'Java man'. Dubois claimed that his Java man was "the transition form which in accordance with the teachings of evolution must have existed between man and the apes." Several other specimens of *Pithecanthropus* were discovered later from nearby sites.

Forty years later, in China, a young palaeontologist, named W.C. Pei, found a similar skull cap embedded in deposits in a limestone cave in a large hill near the village of Zhoukoudian, near Beijing. Pei's find was named *Sinanthropus pekinensis* or 'Chinese man of Peking'. To the public at large it was just `Peking man'. The fossils of Peking man were less than 1 million-year old. Today, of course, we know that both Java man and Peking man belonged to the same species *Homo erectus*, a species intermediate between the first upright-walking human ancestors and modern man.

The oldest and most complete specimens of *Homo erectus* came up at a site at Nariokotome on the western



The 'Turkana boy', the oldest and most complete specimen of *Homo erectus* discovered in Kenya

shore of Lake Turkana in Kenya in 1984. The discovery of the fossils was made by Richard Leakey's team. It was almost an entire skeleton, fragmented, of course, of a boy, who must have been no more than nine-years old when he died at the edge of the ancient lake, more than 1.5 million years ago. The specimens soon came to be known as the 'Turkana boy'.

The age at which the Turkana boy died was inferred from his teeth growth pattern. At the time of his death his second molar was beginning to show through. In modern human children this would happen at the age of 11 and in apes at age seven. Since the place of *Homo erectus* was somewhere midway it was reasonable to assume that the boy had died when he was nine.

Even before the Turkana boy turned up at Nariokotome the importance of *Homo erectus* in human evolutionary history was well recognised, but all earlier fossil finds were limited to only a few fragments of the anatomy. The hundred or so individuals known from various parts of the world, including the Java and Peking man, were represented for the most part by fragments of skulls and jaws, and in a few cases, fragments of thigh bones. So, until 1984, only a fraction of the overall anatomy of *Homo erectus* had come to light.

The discovery of the almost complete skeleton of the Turkana boy laid to rest the earlier ideas about the physical appearance of *Homo erectus*. Ever since Dubois' time, it was believed that *Homo erectus* (Peking and Java man) was a 'squat, heavy-boned and powerfully muscled' creature. The Turkana boy changed all that. According to Alan Walker—Richard Leakey's team-mate who led the group that studied the skeleton—the boy would have grown to a tall, slender adult with a height not less than 1.8 m. He was built "much like the people who live around Lake Turkana today—people whose long, slender limbs and bodies are good at shedding the heat load mercilessly imposed by the sun." What is more important is that the Turkana boy

represented the earliest human ancestor known to science whose general body proportions matched those of living people.

In facial appearance, *Homo erectus* was not much different from its predecessor, *Homo habilis*. The face still had protruding jaws, no chin, thick brow ridges and a long, low skull, although its teeth were somewhat smaller. But what distinguished it from its predecessors was its rather large brain, with a volume close to 1,000 ml, compared to 680 ml for *Homo habilis* and 1,350 ml for modern humans.

With its larger, more complex brain, *Homo erectus* certainly had better intelligence than its predecessors and must have developed intellectual curiosity none of its predecessors was endowed with. It may even have had some capability of speech. We can tell about the higher intelligence of *Homo erectus* from the variety of 'advanced' stone tools and weapons found at the excavation sites. These included large quantities of double-edged, teardrop-shaped 'hand axes' and other sharp-edged cutting tools.

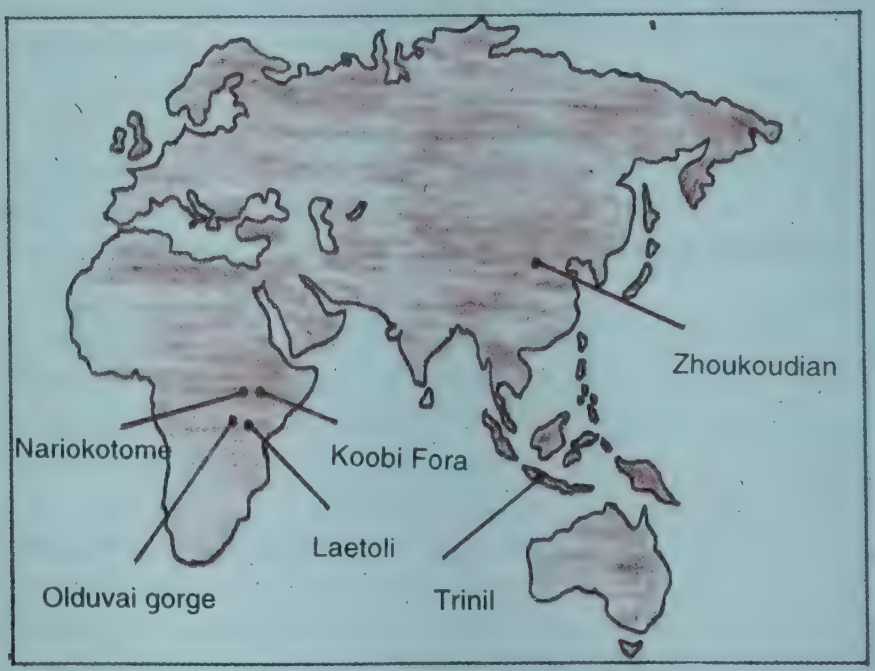
Evidence from China and elsewhere where charcoal has been found at several sites suggests that *Homo erectus* also knew how to control fire and cook food. This may have been one of the factors that led to a reduction in teeth size in later human ancestors, because chewing cooked food needs less force than chewing raw meat or uncooked food.

The larger brain capacity may also have endowed *Homo erectus* with an urge to venture out beyond its immediate neighbourhood in search of new pastures. Like humans today, he must have wanted to see what was on the 'other side of the mountain'.

Another factor that may have made *Homo erectus* move out of Africa could be population pressure due to increasing numbers at the few favourable locations. But, whatever may have been the driving force, with its better hunting and foraging skills and substantially improved capability of exploiting the environment, *Homo erectus* may not have

faced much difficulty in moving into a new unexplored territory. And so, with *Homo erectus* began the big exodus out of Africa, about 1 million years ago. They spread far and wide as fossil evidences from China, Southeast Asia and, more recently, from the Narmada Valley in India show. Surprisingly, no definitive fossil evidence of the presence of *Homo erectus* has been found in Europe. The Ice Age glaciation prevailing in that part of the world at that time may have prevented the early human wanderers from venturing north onto the frigid ice-covered land, at least temporarily.

When populations of *Homo erectus* began to move out of Africa about a million years ago, they carried their improved knowledge of tool making with them which was crucial for their survival in an unknown, hostile environment. As they spread across Europe and Asia, they improved their tool-making techniques—broad flakes gave way to narrow blades. The blades were further shaped to



Sites where *Homo erectus* fossils have been discovered, clearly showing their wide spread

produce the finest of implements. By about 700,000 years ago, as many as 20 or 30 different tool types, with points and edges and curves never seen before were known to exist. These mute stones, products of a different kind of mind at work, tell the story of a real change in the path of human history.

Besides improved tool making, *Homo erectus* migrants brought in a different kind of change. Faced with unfamiliar environments in their new homes, they rapidly evolved area-specific adaptations which helped them cope more successfully with the new environments. The change in skin colour may have been one of them.

It is not yet known for certain why the skin colour of people differ. According to the most widely accepted theory the difference in skin colour has something to do with the production of vitamin D, essential for proper bone formation. The cells of the human skin, like the cells of the rest of the human body, contain a chemical substance similar to cholesterol that can be converted to vitamin D. In order for this to happen, however, one of the six-carbon rings in this substance must be broken and that happens when the skin is exposed to ultraviolet rays present in sunlight. Once this ring is broken, and only then, the compound enters the bloodstream and enzymes present in the liver and the kidneys complete the conversion into vitamin D. Lack of exposure to enough sunlight has been known to result in vitamin D deficiency, leading to various kinds of bone abnormality in children.

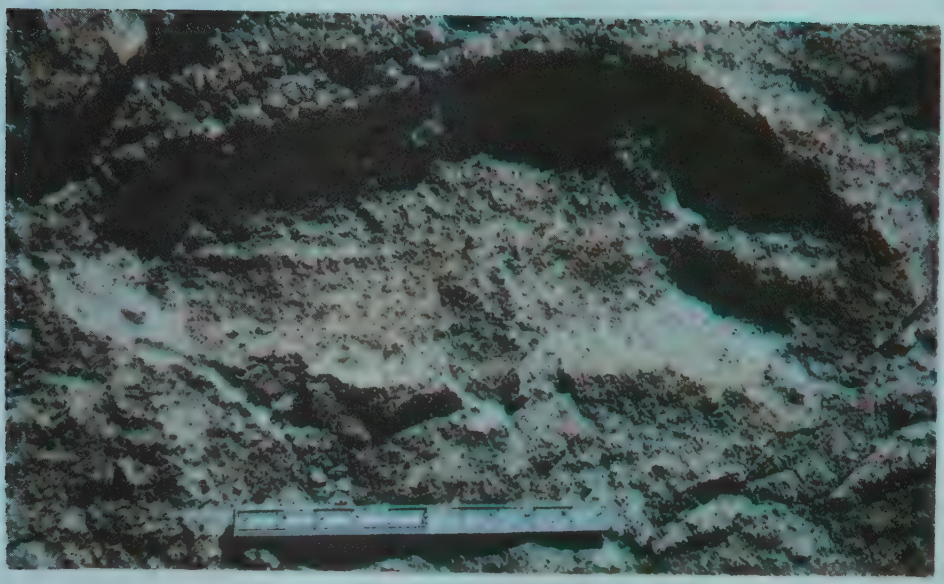
As *Homo erectus* moved into cooler lands of Europe, where sunlight was not as abundant as in tropical Africa, their brown skins would have been a problem. Not only was a layer of protective pigment no longer necessary against the mild sun, but the pigment would also have prevented the synthesis of vitamin D in the skin. So some of the migrants living in cooler climates must have lost, over a few generations, much of the skin pigmentation, and become white skinned. In this way, regional physical

distinctions may have become gradually established.

From the size of the skull of the Turkana boy it has been estimated that *Homo erectus* infants were born with brains one-third the size of the adult brain, as in modern humans. It is quite possible, then, that the Turkana boy also must have come into this world in a helpless state, like modern human infants do. This could mean that the intense parental care of infants which is a part of modern human social milieu had already begun to develop in early *Homo erectus*, some 1.7 million years ago.

With its larger brain, and greater intelligence, *Homo erectus* represented a pivotal point in human evolution. It can be said that whatever came before it was more apelike and whatever came later was more humanlike.

Over a period of a million years *Homo erectus* evolved gradually. By around 500,000 years ago some of our ancestors looked sufficiently like us, and sufficiently different from earlier *Homo erectus*, to be classified as our own species, *Homo sapiens*.



3.6 million-year-old footprint shows clearly the raised arch, rounded heel and forward-pointing big toe necessary for walking upright

Footprints of *Australopithecus afarensis* discovered at Laetoli.

Fossilised remains of Lucy, the most famous specimen of *Australopithecus afarensis*

Reconstruction of an *Australopithecus afarensis* male by American artist John Gurche

Neandertal man—a display at the Neandertal Museum in Erkarth, Germany

25,000-year-old carved ivory head known as the Venus of Brassempouy discovered in France

15,000-year-old Venus figurines made of ivory from Siberia

23,000-year-old sewing needles made of ivory

26,000-year-old head carved of mammoth ivory

Bas relief of a bison head created by human ancestors 16,000 years ago

Bisons sculpted in clay 15,000 years ago in a cave in the French Pyrenees

Strange animals painted by Upper Palaeolithic artists in the Lascaux Cave in France some 17,000 years ago

The head of a bison painted at Lascaux

Cave paintings made 10,000 years ago at Bhimbetka in India.

Elephant with rider at Bhimbetka

5

THE NEANDERTALS

A display at a museum in Erkarth, Germany shows a well-dressed individual who at first glance could be mistaken for one of us modern humans. But a closer look would reveal that this individual is no human, his face is distinctly different from ours, with a flatter skull cap, high browridges, large nose and protruding jaws. He is one of our closest ancestors—the Neandertal man.

Ever since the discovery of the first fossils almost 140 years ago, the true nature of the Neandertals has been shrouded in mystery. They have been described as "big-browed, dim-witted brutes with traits more primitive than humanlike—hulking subhumans of low intelligence."

When the first fossil skeleton of a Neandertal was discovered in a limestone cave near Dusseldorf in the Neander Valley (*tal* means valley in today's German, but the word was spelt *thal* in the nineteenth century) in 1856, no one had any idea of human evolution. The knowledge that modern humans have evolved from some ape-like creature had still not taken root. So, when limestone miners found pieces of what looked like a human skeleton, no one really understood its real importance. The skeletal pieces were not quite humanlike, though. The skull had angling browridges and a low-sloping skull cap; the limb bones were exceptionally thick to belong to a human. Even the local science teacher into whose hands these skeletal remains fell thought them to belong to a 'refugee from Noah's flood'. Others of his time thought that the creature was 'some poor idiotic hermit', possibly a sufferer from rickets.

Lacking the knowledge of human ancestry, the Neandertal skeleton was taken to be no more than that of some deformed human.

One of the earliest to provide a detailed description of a Neandertal skull was T.H. Huxley. In his book *Man's Place in Nature*, published in 1863, Huxley accepted that it was the most simian (ape-like) human skull yet discovered, but pointed to the large brain capacity and argued that the specimen fell within the possible range of variation for *Homo sapiens*. But others thought that the differences were so great that the individual must belong to a distinct species of early humanity. The name *Homo neanderthalensis* was coined by William King in 1864. Today, however, Neandertals are considered to be a subspecies of *Homo sapiens*, the species to which modern humans belong.

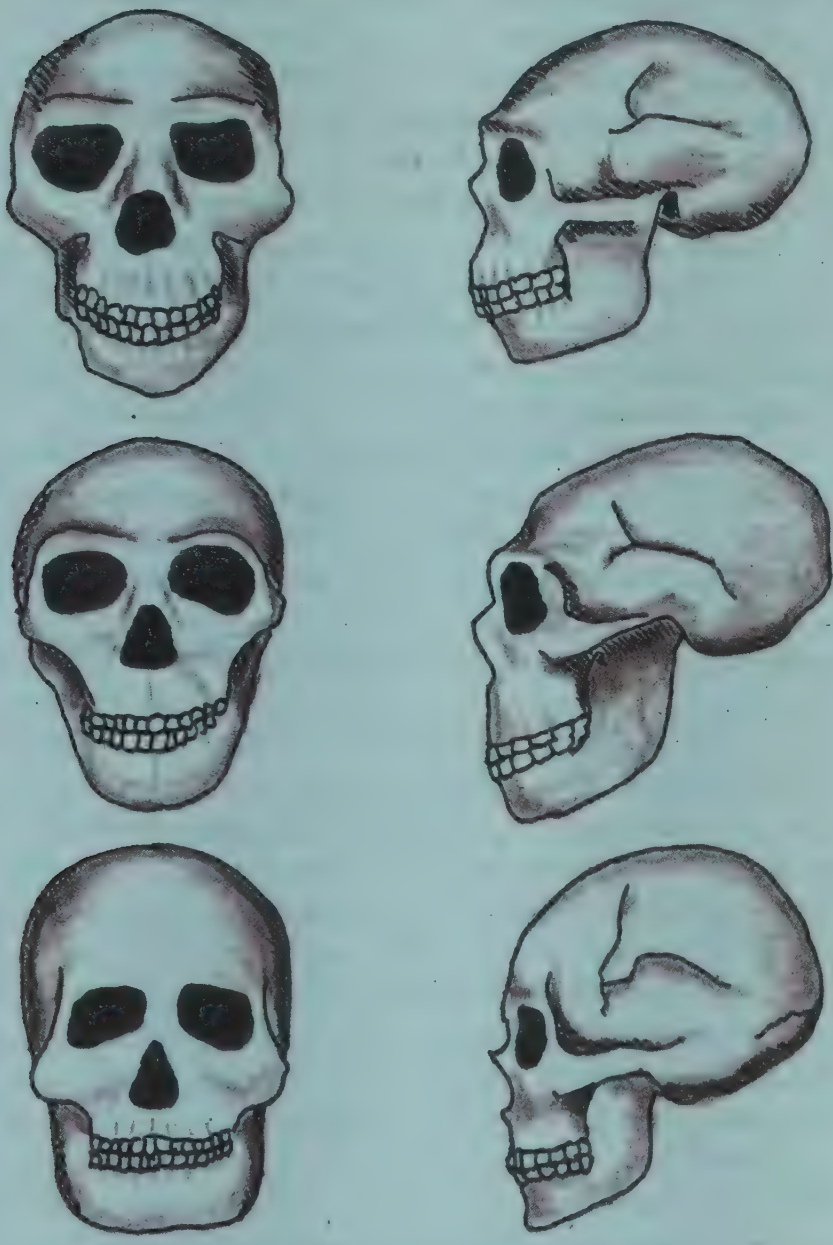
Gradually, as remains of Neandertals came up at more than a hundred sites, stretching from Europe to West Asia, the true nature of these human ancestors started coming to light. It is now known that Neandertals inhabited Europe from about 250,000 years ago until they vanished around 30,000 years ago. What is most surprising is that for a period as long as 10,000 years before they became extinct, Neandertals may have lived side by side with the modern humans, as some recent finds indicate.

From the vast quantities of fossils collected over a period of several decades we can recreate a reasonably accurate likeness of a Neandertal, like the one on display at the Neandertal Museum in Erkrath, Germany. It can now be said with some certainty that in appearance the Neandertals were not so different from us, although they were more robust. Thick, heavy bones with markings of powerful muscles reveal a people capable of enormous exertion and endurance.

The appearance of Neandertals has been succinctly described by Richard Leakey: "Imagine a modern human face made of rubber. Now take hold of the nose and pull it out several inches. The result is an oddly protruding central

portion of the face, not just the nose but everything around it. That, roughly speaking, is a Neandertal face."

Not only were the Neandertals shorter and more



Skulls of *Homo erectus* (*top*), Neandertal man (*middle*), and modern humans (*bottom*) bringing out the distinctive features that distinguish modern humans from the rest

heavily built than their ancestors *Homo erectus*, they also had a much larger brain, in fact, slightly bigger than the brain of the average modern human. But in proportion to the overall body size the Neandertal brain was smaller than the average human brain. It was also less complex, with fewer folds. The larger brain endowed the Neandertals with capabilities to fight the elements. They were the first human ancestors to have learnt to live in a climate much colder than the scorching heat of tropical Africa.

From fossil records, we know that Neandertals roamed as far north as Britain and as far south as Spain in Europe and later extended east into Central Asia and West Asia. But their population was never very large—at any one time, probably never exceeding some tens of thousands.

In the north, the Neandertals for the first time came face to face with something its predecessor never had to contend with—frigid wilderness—and gradually over thousands of years they adapted to survive. Their anatomy bears witness to this adaptation. Their short limbs and stocky bodies were quite like the Eskimos of today, ideally suited to prevent loss of heat in a cold climate. Their broad noses provided more inner surface area to add moisture to the frigid, dry air they had to breathe. Also in a land devoid of much vegetation or small game their powerful musculature enabled them to kill big game, such as bison or elk which provided food for their sustenance. Lacking elaborate weapons, Neandertals killed big game through cooperation. They surrounded and drove the pray into a bog or a stream bank and then attacked it with sharp-edged weapons like stone-tipped spears. A wooden spear almost 2.5 m long was found among the bones of a fossil elephant discovered in a bog in Germany in 1948. Not surprisingly, killing big game had its risks as well and serious injuries were not uncommon. Fossil evidence show that head and neck injuries were quite common among Neandertals.

A large majority of Neandertal hunting injuries resulted from their trying to spear the prey from close range as

they did not know, it is believed, the art of throwing a spear from a distance. This is surprising because, as tool-makers they were quite capable. For instance, the Neandertals travelled long distances, often several kilometres, to collect just the right pieces of flint for making tools. Moreover, making the kind of tools found at Neandertal sites needed quite some training as some recent studies show. In fact, it is now accepted that "the techniques used by the Neandertals are no less difficult than those used later by modern humans."

Large numbers of tools found in Neandertal sites are thought to be scrapers used in dressing hides for clothing, although there is no evidence that they actually used any form of stitching. But, curiously, the Neandertals, like present-day Eskimos, show a high degree of wear of the front teeth, suggesting that they used them as a third 'hand' to hold hides as they worked on them.

To be able to make the kind of tools they made and to organise a cooperative hunt to kill large game, the Neandertals must have made use of some kind of language to pass on their knowledge and instructions. Studies of Neandertal skulls show that their owners must have possessed some kind of a voice chamber similar to a modern human's but not as large. So, it is possible that the Neandertals did have the capability of producing a wide range of sounds for communication, but may not have had a language as complex as ours. That required the more advanced brain possessed by modern humans.

We know that the Neandertals took shelter from extreme climates in caves and rock shelters, and that they knew the use of fire. But what was their social life like? Lewis Binford, an American archaeologist, has come up with some startling facts about Neandertal lifestyle based on fossil bones and stone tools found in caves and rock shelters. Neandertal men and women, he believes, lived strangely separate lives. They ate different foods; used different stone tools. After analysing thousands of

fragments of animal bones and stone tools discovered at a site called Combe-Grenal in southwestern France, Binford stumbled upon a curious fact. The animal bone fragments and stone tools found in the caves and rock shelters were quite different from the bones and tools found outside, away from the caves and rock shelters. The fragments found in the shelters mostly came from marrow bones and skull of large animals which could be heated in fire to get at the delicacy inside. The tools found here were simple, made from stone that came from the cave itself or at most a little distance away. These remains were always found along with ashy material which indicated that fires had burnt there.

Sites which contained the bones of the rest of the animal had tools of much higher sophistication—scrapers made of stone often collected from far away locations. Interestingly, the sources of the scraper rocks could be linked to the kind of animal bones found in the shelter. When the scraper rocks came from the uplands, all the bones came from upland animals like horses. If the rocks came from the river valley, the bones came from valley animals like pigs. On the basis of the kind of bones found in the shelters, Binford suggests that Neandertal men did not carry the entire kill back to their womenfolk who remained in the shelters. They only brought back skulls or marrow bones. "If you heat them, you're going to get more fat than if your open them up in the field and just eat," he says.

A typical Neandertal group sharing a shelter, according to Binford, would have comprised some 12 adults and some kids. The menfolk did not stay at these shelters on a regular basis but returned periodically after hunts. The womenfolk and the kids mostly survived on fruits, berries or roots roasted on fire, and occasional delicacies like bone marrow brought by the menfolk once in a while. The menfolk ate up most of the kills they made, especially the meaty parts, away from the shelters. In fact, although the

A typical Neandertal habitation

Neandertals were quite intelligent by primitive standards, they were unable to plan into the future and make full use of the resources around them.

Their intellectual inadequacies notwithstanding, the Neandertals were a caring lot, as is evident from their burial sites and injury marks on skeletal remains. They were the earliest known human-like creatures to have buried their dead. At a 100,000-year-old burial site in a cave in Iraq, skeletal remains of a male, two females and an infant were found along with pollens of flowers. Possibly the flowers, collected from nearby fields, were placed beside the bodies as part of some burial ritual. What is more surprising is that many of flower species used in the burials were traditional herbal medicines. Other skeletons recovered elsewhere show marks of healed injuries—injuries that must have needed some sort of nursing and caring for some length of time to heal. Despite such care and compassion, however, the Neandertals did not live long, possibly because of their tough lifestyle. It appears that for those who made it to adulthood, the average age at death was 30, although

skeletons of 40-year-olds have also been found.

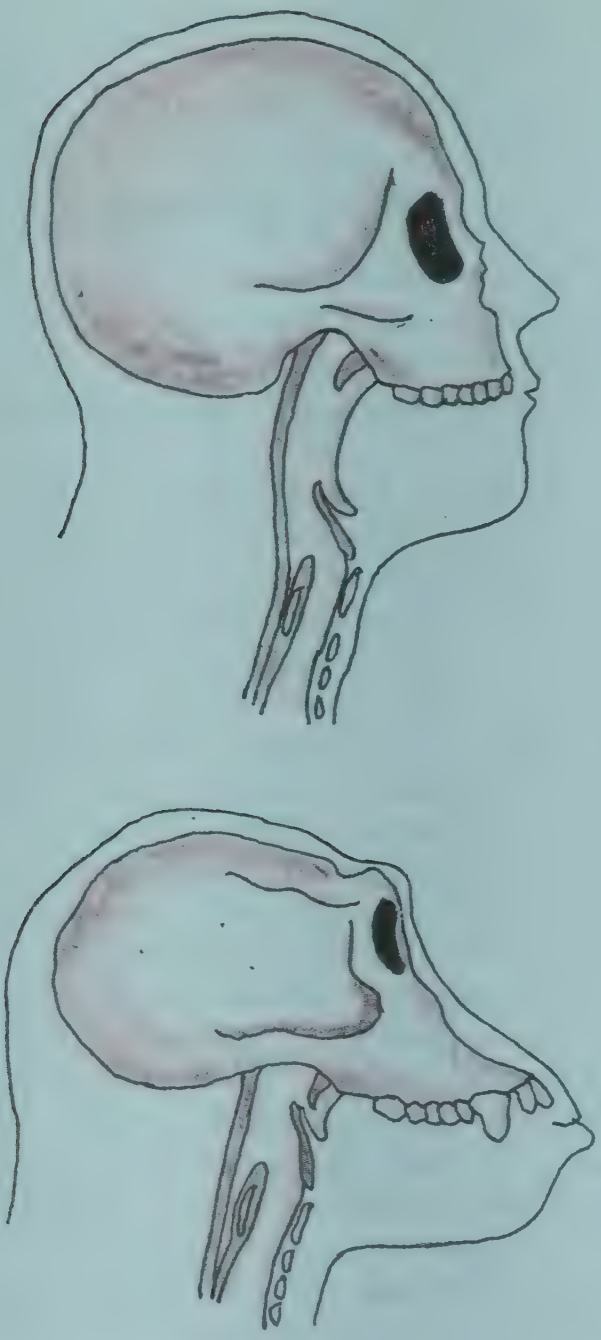
Fossil records from several sites tell us that around 40,000 years ago, modern humans, true *Homo sapiens* had moved into Europe. They were intellectually superior to the Neandertals and were armed with innovations such as better tools with finer blades, tailored clothing, better shelters, more efficient hearths and most importantly, as we shall see later, the power of speech. These modern humans lived side by side with Neandertals for almost 10,000 years till the latter died out. It has not yet been established what really caused the extinction of a robust species like the Neandertals. It is also not known for certain whether Neandertals interbred with modern humans, although it has been suggested that "Neandertal genes persist in modern Europeans of today." Whatever the cause, by about 30,000 years ago only one human species dominated the earth. It was the *Homo sapiens sapiens*.

6

FIRST WORDS

Thomas Henry Huxley, a close friend of Charles Darwin and one of his ardent supporters, was quite aware of the importance of articulate speech and language that makes us humans different from all other members of the animal kingdom. Writing in a small book of essays entitled *Man's Place in Nature*, published in 1863 he observed, "No one is more strongly convinced than I am of the vastness of the gulf between...man and the brutes...for he alone possesses the marvellous endowment of intelligible and rational speech...stands raised upon it as on a mountain top, far above the level of his humble fellows, and transfigured from his grosser nature by reflecting, here and there, a ray from the infinite source of truth." Huxley was not far from the truth, for the human spoken language is unlike any other in its capability of conveying vast amounts of information in a precise manner. When we say, "a rose smells sweet", we precisely identify the flower and also the sensation its fragrance produces in our nose. The same cannot be conveyed through grunts or gestures most animals use for communicating with others of the species.

Having said that, the question now arises: what is it that endows modern humans with the power of speech and which is not found in its ancestors? Finding that out was not an easy proposition. This is because, unlike jaws, teeth, bones and skull which are durable and leave behind fossilised remains, the vocal organ that is the key to articulate speech, and the brain the complexity of which provides clue to the intelligence of its owner, are made of soft tissue that



Voice organ of apes (*top*) and humans (*bottom*) showing the larger throat cavity of humans that endows them with the power of speech

does not fossilise. But there were indirect routes to approaching the problem.

In order to solve the riddle of spoken language let us first see how our voice organ differs from, for example, the ape's. In both apes and modern humans, the vocal apparatus is made up of the larynx, the throat, the tongue, and the lips.

Human beings can produce an enormous range of sounds. This variety of sounds comes from many sources. Human speech is actually made up of raw sounds shaped into combinations of consonants and vowels. The raw sounds are produced in the voice-box or larynx, by the vibration of a pair of elastic vocal cords produced by air expelled from the lungs through the windpipe. The top and bottom parts of the larynx can move relative to each other, stretching or relaxing the vocal cords which changes the pitch of the sound produced. The force with which air is expelled decides the loudness. The sounds are shaped into speech in the mouth by the teeth, tongue, palate, and facial muscles. The ability of humans to produce the wide range of sounds needed for articulate speech stems from the large size of the pharynx, or throat cavity—the space between the vocal cords and the upper part of the mouth—due to the larynx being situated low in the throat. This allows more freedom to the larynx to expand and contract and thereby produce a fairly wide range of sounds.

The apes on the other hand have their larynx high up in the throat which makes their throat cavity quite small. This drastically limits the range of sounds that apes can produce compared to humans. So they do not have the ability to produce spoken words like we do. In fact, it is now recognised that the expanded throat cavity could well have been the key to our ability to produce fully articulate speech—the hallmark of our humanness.

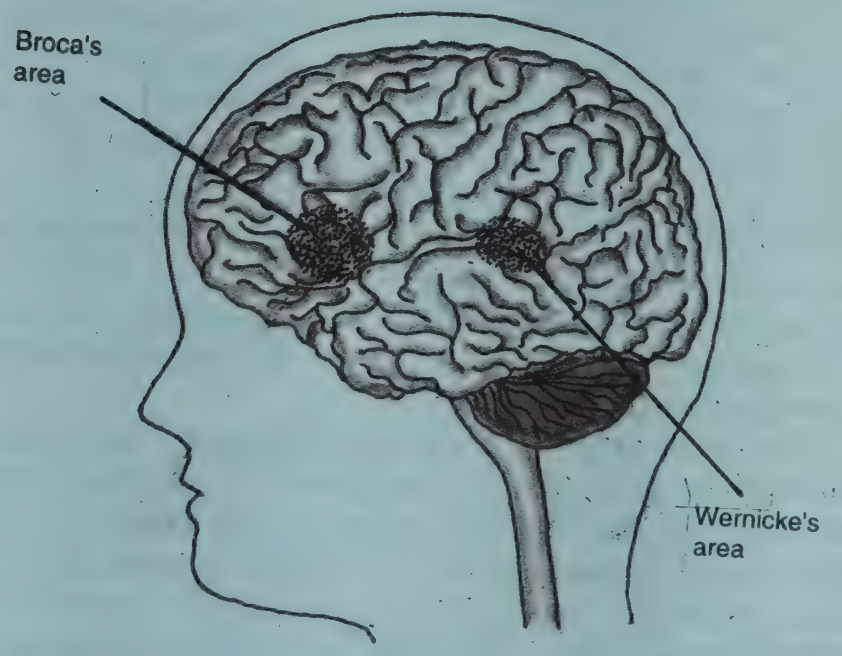
An interesting point to note here is that the shape of the vocal tract of a new-born infant is almost identical with that of the apes—the larynx is high up in the throat. So, a

new-born baby, up to an age of about a year and a half, is unable to produce articulate speech. But this deficiency is more than made up by an advantage a new-born infant has but grown up humans lack. The high placement of the larynx enables the human infant and apes to do the seemingly impossible feat of swallowing food and breathing at the same time without choking. Motion pictures taken with X-rays have shown that new-born and young human infants breathe, swallow and vocalise in the same manner as monkeys and apes do. Until the age of a year and a half, the position of the larynx in a human child is high up in the throat like any other non-human primate. But later, the larynx begins to descend into the throat. This descent spectacularly modifies the manner in which the child breathes, swallows and vocalises. It is this change in the position of the larynx that enables the child to utter his first words. But now he loses the ability to swallow and breathe at the same time without choking.

But mere presence of a large throat cavity is not sufficient for articulate speech. The brain also has to be developed sufficiently to coordinate the thought processes that go into making sense of the 'words' spoken.

The human brain is not only bigger than that of its evolutionary predecessors, it is also far more complex. The brain has two parts. The larger, dome-shaped part is called the cerebrum. It is the 6-mm-thick surface layer of the cerebrum, called the cerebral cortex, which is the seat of intelligence and where the brain stores and processes all the information it receives from the various sense organs of the body. The smaller part of the brain, called the cerebellum, is located at the back below the cerebrum. It is primarily concerned with the coordination and regulation of muscle activity.

The cerebrum is divided vertically from front to back, into the left and right hemispheres. Each hemisphere can be further divided into four sections, or lobes, each lobe being responsible for a different set of functions. For example, the



The speech centres of the brain: Broca's area (*left*) and Wernicke's area (*right*)

front lobe is associated with movement and emotions; the lobe at the back takes care of among other things, visual functions; the lower side lobe is important in memory storage; while the upper lobe plays an important role in integration of such senses as hearing, vision, smell and touch.

While the size of the brain is a good indicator of intelligence, what is more relevant is the area of the cerebral cortex made up of what is commonly known as grey matter, where most of the brain's information is stored and processed. As the brain size increases, the area of the cerebral cortex also increases. But in humans the total area of the cerebral cortex is much larger than it would be if it were simply proportional to the brain size. This is because the cerebral cortex in human brain is not smooth as in most animals and early human ancestors, but has an enormous number of folds which allows packing of the maximum

amount of grey matter within the confines of the skull.

Neurologists have identified two language centres in the brain that give us the capability of using spoken words. They are named Wernicke's area and Broca's area, after the nineteenth century researchers Paul Broca and Carl Wernicke who first discovered them. Out of the two, Broca's area is the more prominent one, appearing as a raised lump on the front left side of the brain. Evidence of the presence or absence of Broca's area in the brain could therefore be taken as an indicator of the language ability of a pre-human species.

So there are two indicators to enable us to decide whether any of our human ancestors were capable of using spoken words like we do or did they have to make do with mere growls, grunts and a few other sounds for vocal communication. One is the position of the larynx in the throat and the other, the presence of Broca's area in the brain. Unfortunately, evidence of none of these two can ever be found directly as the organs in question do not fossilise. But there are indirect methods which have been used with quite some success.

After studying hundreds of fossil skulls of apes, and early and modern humans, Jeffrey Laitman of Mount Sinai Hospital Medical School, New York and his colleagues found a striking relationship between the position of the larynx and the shape of the base of the skull. In apes, which have a larynx high up in the throat, the base of the skull is quite flat. In contrast, in humans, with a larynx situated lower in the throat, the base is distinctly arched. After studying fossil skulls of *Homo erectus* and other later hominids, Laitman discovered that changes in shape of the base was noticeable right from about 1.6 million years ago, around the time the earliest *Homo erectus* lived. But even in Neandertals the arching was not sufficient to endow them with a capability of speech similar to that of modern humans.

The evidence for Broca's area in ancient brains comes

The shape of the base of the skull of *Homo erectus* (*top*) is more flatter than the skull of modern humans (*bottom*) showing speech capability in the latter

in a more dramatic manner. It has been known to scientists who study fossil skulls that the brain leaves tell-tale marks on the inside surface of the skull that once housed it. It was also known that a replica or a 'cast' of the brain impression can be easily made by using liquid latex. If the brain had a Broca's area it would certainly show up in the cast. And so it did, in a fossil skull a little less than 2 million years old belonging to the earliest of the *Homo* species called *Homo habilis*. Of course, in *Homo habilis*, the Broca's area was not well developed as in modern humans. This, combined with its much smaller brain size, indicates that *Homo habilis* had only rudimentary language abilities.

According to American anthropologist Ralph Hallo-

way, who had made extensive studies of fossil skulls, "The form of the language was undoubtedly primitive, but carried with it a limited set of sounds systematically used, and was based on a well-known aspect of primate sociality—the ability, if not the penchant, for making vocal noise."

It now appears from the study of fossil skulls—the shape of their bases and internal casts—that a rudimentary capacity for spoken language may have had a beginning right from the time *Homo habilis* appeared. But it was only with the coming of modern humans, *Homo sapiens sapiens*, with its much larger and more complex brain that articulate speech really came of age and played a decisive role in changing the course of human evolution.

Recent research shows, however, that the language organisation is much more complex than had been imagined earlier. For example, it is not just Broca's area and Wernicke's area in the brain that take part in speech production and comprehension. We know now that virtually every part of the brain is involved. We must take into account this immensely significant fact into account for any explanation for the evolution of our ability to speak and understand language.

We must also remember that merely having the right kind of voice-producing organ and a highly developed brain is no guarantee that an individual would be able to speak. One has to learn to speak, and that involves a good sense of hearing and memory. A child utters his first 'words' around the age of 15 months or so. He gradually picks up other words and their meanings as he grows. But he cannot do so unless he hears others say those words. A child who is deaf from birth cannot learn to speak in the normal way even though he may have a perfectly formed voice organ and a normal brain. Thus, we see that the way we speak and understand speech depends a lot on what happens after brith; it is not an inborn capability like crying and laughing which come without training. It is really

amazing that a simple everyday activity of ours like talking, which we all take for granted, had taken so long—millions of years—to evolve. But whatever the trigger, probably a genetic change, that made our distant ancestors hit upon a new, more versatile means of communication, there is no doubt that the mastery of articulate speech signalled a change of far-reaching consequence in the long path to the evolution of modern man.

7

MODERN MAN EMERGES

Cro-Magnon is a place in southwestern France. Here, in 1868, while digging for laying a railway line, the workers unearthed the fossil remains of what can be called the earliest of modern human, *Homo sapiens sapiens*. From the fossil remains of five skeletons it was obvious that they belonged to creatures anatomically identical with present-day humans. Unlike the Neandertal skull, the skull of these individuals had a high forehead, a distinct chin and greatly reduced browridges which gave them an appearance almost indistinguishable from modern man. It was named 'Cro-Magnon man' after the place of its discovery. Other fossil finds, especially bone remains of animals such as reindeer and bisons near Cro-Magnon sites provide evidence that these ancestors of ours were far advanced than the Neandertals in tool-making and hunting skills and had extraordinary artistic ability. But, more importantly, from their skull structure we can tell with almost certainty that they had a language of communication through speech which is the hallmark of modern humans.

Cro-Magnon man was the first true human to settle in Europe around 35,000 years ago. But his origins possibly go back to around 100,000 years ago, in Africa, as has been revealed by the discovery of a human skull, some 110,000-years old, in a cave in South Africa. Similar finds in a cave called Qafzeh in Israel, have been dated to be around 92,000-years old using a technique called *thermoluminescence*. These dates were not only much older than any computed before for modern humans, but they also put all

previous ideas about the evolution of modern humans in jeopardy. For instance, if modern humans were as old as the Neandertal man then how could the former have 'evolved' from the latter as was believed earlier?

Most palaeoanthropologists now agree that both modern humans and the Neandertal man have evolved from the same stock—*Homo erectus*—in Africa. In fact, from the analysis of the genetic material called DNA found in the mitochondria of cells, scientists have concluded that the ancestry of every living person on this earth can be traced back to a female who lived in Africa some 200,000 years ago. Such a deduction is possible because mitochondrial DNA is passed on from mother to offspring unchanged, unlike the DNA found in cell nucleus half of which is inherited from each parent. But mitochondrial DNA does change with time due to natural mutations, and the rate at which these changes are brought about is more or less constant. By comparing the amount of variation in mitochondrial DNA in different populations, therefore, it is possible to work out the length of time that has elapsed since that population originated. So it is, we are all descendants of a common mother, the African 'Eve' who lived some 200,000 years ago.

Now it appears that between 400,000 and 200,000 years ago, there began a remarkable change in *Homo erectus*. There was the beginning of a much bigger increase in brain size and thinning of the skull bone, till by about 250,000 years ago, when the earliest *Homo sapiens* appeared. They looked like modern humans in all except minor anatomical details and were named *Homo sapiens neanderthalis*, or Neandertal man. By 120,000 years ago, *Homo sapiens sapiens* or modern humans had appeared. Thus by 100,000 years ago, two subspecies existed, although not necessarily side by side. Neandertals moved out of Africa first, around 250,000 years ago. Modern humans followed more than 200,000 years later. It was the remains of these people that were discovered at Cro-Magnon in 1868.

Cro-Magnon man arrived in Europe around 35,000 yeas ago, which marks the beginning of the Upper Palaeolithic or late Ice Age, setting off a remarkable change in the way our ancestors lived and worked. It was the period when much of Europe was in the grip of the late Ice Age and our ancestors had to innovate to face it. Not surprisingly, fossils recovered from various Cro-Magnon sites in Europe provide one of the most exciting stories of new ideas and practical advances in the whole span of the human past. The tools recovered from many of these sites showed real innovation. Upper Palaeolithic tool-makers no longer produced tools from only locally available stones. They used pieces of special types of rock which were hard and could be made into sharp-edged blades similar to modern knife blades. This allowed these craftsmen to obtain 10 times more usable 'cutting edge' than could their Neandertal predecessors from the same amount of stone.

Another innovation that these early modern humans achieved was the use of some sort of 'handle' made of wood or bone to mount the stone tools. This innovation enabled them to make use of the stone tools more efficiently as we do today. After all, we do not use knives, axes or scythes without handles! The early humans used these tools not only for cutting and scraping as their predecessors did, but also as chiselling and perforating implements. Remains of such stone tools have been discovered in rock shelters at hundreds of sites including rock shelters at Bhimbetka near Bhopal in India.

One of the most distinctive inventions of the Upper Palaeolithic people was spear-shaped weapons made of bone or antler. By about 20,000 years ago these people had invented a deadly device called 'atlatl' for launching their spears with improved accuracy and much higher velocity than is possible by throwing by hand. Obviously, armed with such an advanced killing device, the early modern humans did not have to risk their lives like their Neandertal

Palaeolithic spear-thrower used by early modern humans to kill big game

cousins for killing big game. There is evidence that these people could easily kill large bisons using these advanced weapons.

One of the problems of trying to unravel the past on the basis of only fossil records is that it can often mislead us because many things that our distant ancestors used may not have left any fossils. Use of textiles, for example, cannot be ascertained from fossil records. Fortunately, there are exceptions and occasionally palaeontologists stumble upon them. One such fortuitous discovery was made near rock shelters at Lascaux in France in the early 1940s. Excavations at the site produced what is thought to be the earliest known evidence of the use of rope or cord. Samples of humus dug out from the site showed unmistakable shapes of braided plant fibres similar to ones used today for making jute or coir ropes. This must have been a significant technological development of that time, because people

who mastered the art of rope making must have also had the knowledge of using it in different ways. For example, ropes and cords can be easily used for making nets and snares which can enormously enhance the hunting and fishing skill of their makers.

Unlike the Neandertals who used fire only for roasting meat and tubers, the Cro-Magnons and their contemporaries used fire also to light up and to boil water. The lamps of these early humans were made of hollowed-out limestone slabs. Instead of oil they probably used animal fat with a moss or cord wick. Hundreds of these limestone lamps have been discovered from Upper Palaeolithic sites in Europe. Ash deposits found at these sites show that wood and animal bones served as the main fuels.

Not only lamps, these early humans also developed a unique method of boiling water. In the absence of a cooking pot what these people did was quite simple. Rather than putting the pot of water over fire they just put the fire, in the form of red-hot cobbles, into the water, probably contained in skin-lined pits on ground. Evidence of such a technique having been used comes from several sites in the shape of pits full of fractured cobbles as would be obtained by sudden cooling of red hot stone by water.

Another remarkable thing about these people was that they knew how to save fuel for heating, especially in winter in the cold mountainous regions of Europe. In France and Ukraine more than two-thirds of the sites where the early humans lived are located on south-facing slopes and at the bases of south-facing cliffs. Obviously they were aware of the fact that such locations absorb heat from the sun during the day and yield it slowly at night. Like modern humans, these early humans also preferred to live near sources of water such as rivers and lakes. They usually chose to live in caves or rock shelters if water was nearby. But many open-air sites have been discovered, located often several kilometres away from any cave or rock shelter. More than 90 per cent of the sites discovered

in Europe are believed to have been located near springs or on the banks of rivers and streams.

From the remains of the open-air sites, it appears, these people carefully built their dwelling places to make them safe and comfortable. These dwellings were mostly built on carefully prepared foundations—pavements or platforms made of cobbles or stones. The early dwellings may have been no more than simple conical tent-like structures made from animal skins spread over a frame of wooden poles or animal bones. But by 15,000 years ago, spectacular architectural designs had evolved. From the remains of shelters found at more than a dozen sites discovered in Ukraine we know that the primary building material here was the bones of the woolly mammoth, ancestors of today's elephants. At one place, bones of as many as 95 of these giant animals were used to make just one elaborate shelter with a covered area of 24 sq m. According to one estimate, 10 men and women could have constructed it in six days, using more than 21,000 kg of

Mammoth-bone shelters testify to the architectural skill of our early ancestors

bone. Interestingly, these bones probably did not come from hunted animals but from skeletons of long dead ones that the builders of the shelters had collected from the surrounding. This was perhaps one of the earliest examples of imaginative architectural use of a natural resource, a typical modern human trait.

Excavation at several Upper Palaeolithic sites have revealed that by 24,000 years ago the art of sewing was known. Of course, the clothing that the people of that time wore has not been preserved; they all must have rotted away. But we know they wore tailored clothes because samples of one-eyed sewing needles made of ivory or bone have been recovered from the sites. The needles are about 8 to 10 cm long with a sharp point at one end and a tiny eye at the other, much like the large steel needles used for sewing gunny bags today. The 'thread' used for sewing was probably animal sinew or long plant fibre. Whatever the material used for sewing, there is no doubt that the Upper Palaeolithic people used tailored clothing, probably made from animal skins.

If they wore tailored clothes what did they look like? We have some idea of that too, from excavations made at a 24,000-year-old site at Sungir in northern Russia. The skeletons found here were covered with thousands of stone and ivory beads that had apparently been sewn onto the skin garment worn by the dead individuals. From the outline of the beads found on the skeletons, we can infer that the dress consisted of what has been described as a "tunic pulled on over the head and a one-piece pants/boots combination."

After spreading through Europe and Southeast Asia, populations of modern humans moved into new continents—North America in the north and Australia in the south. From stone tools recovered from sites in the two continents it appears that our ancestors first arrived in Australia and New Guinea (then joined by a land bridge) some 50,000 years ago, crossing at least 100 km of open sea

By about 12,000 years ago, modern humans had spread to almost all the continents

from Southeast Asia. Obviously, those first settlers knew how to build and use rafts or boats. Almost all of the stone tools found in various sites in Australia are of the advanced type, mainly scrapers of various types.

Migration to North America took place much later—around 15,000 years ago—and it may have been over a land route. From past records of glaciations and consequent falls in sea levels, we know that between 25,000 and 12,000 years ago, the continents of Asia and North America were joined by a landmass, now called Beringia, where Bering Strait is located today. Small groups of Asian hunters and their families may have crossed over to North America while following the mammoth herds during their seasonal migrations. When the sea level rose again some 12,000 years ago some migrants may have remained back in Alaska, later moving south to colonise rest of North America and South America. Excavations at many sites in north and southwestern America have brought up fine stone tools and mammoth and bison bones which testify to the technological skill of the first Americans.

But more than their technology, the most widely known yet least understood facet of the life of our earliest human ancestors is the extraordinary works of art produced during their time. Fabulous cave paintings and delicate sculptures have been unearthed from hundreds of sites all over the world.

8

AN ABUNDANCE OF ART

Any form of art is an expression of human creativity. It is not an activity necessary for survival as hunting, for instance, is. Early ancestors of man shaped stones into useful tools, not out of curiosity or the urge to create something beautiful. They did it out of necessity, to hunt for food. The earliest evidence of rudimentary forms of art such as the use of red ochre to decorate dead bodies, comes from Neandertal burial sites. But the real flowering of human creativity was noticeable only around 35,000 years ago during the Upper Palaeolithic, when modern man first settled in Europe and Asia, and later in Australia and North America. For some unknown reasons, scattered hunter-gatherer groups in Europe and Asia underwent a cultural revolution. For the first time in history, humans began to create symbols of themselves and of the animals around them. They left their imprint in the caves and rock shelters they inhabited. Hoards of these exquisite works of art, both paintings and carved objects, have been discovered in thousands of caves and rock shelters scattered throughout Europe, Asia and Australia. They include fabulous cave paintings found in France, Spain, India and Australia, delicate carved figurines and stone bas reliefs discovered in France, Germany and Siberia, and carved ivory and bone ornaments found at many of the sites. An Upper Palaeolithic site in France has even brought forth remains of a 25,000-year-old flute made of bird-bone—the earliest evidence of music, another creative activity typical of humans.

Carved figurines are among the oldest art objects recovered from Upper Palaeolithic sites, and considering their antiquity, they are remarkably advanced in design and execution. About 26,000-year-old human faces carved out of ivory and mammoth bone discovered in France and former Czechoslovakia bring out the high artistic skill of their creators. Sites in Czechoslovakia have yielded numerous fired-clay figurines in the form of humans and animals which are perhaps the earliest evidence of ceramic art.

One of the commonest art objects that show the exceptional artistic skill of the Upper Palaeolithic people are carved female figurines, commonly known as the Venus figures, dozens of which have been recovered from different sites in Europe. These figurines usually portray the different stages of womanhood—from pubescent, to pregnant, to aged. But facial features are seldom represented and most of them feature large and pendulous breasts. Easily passable as pieces of modern art, these figurines were probably used as fertility symbols.

Between 22,000 and 18,000 years ago, a new and dramatic art form in the shape of bas relief became dominant. Carved out of easily workable limestone, these exquisite bas reliefs found in caves in France, depicted horses, bison, reindeer, mountain goats and at least one human figure.

Cute and adorable though the carved figurines and bas reliefs were, the most prolific expression of the artistic capability of our early ancestors came in the form of colourful wall paintings found in caves and rock shelters scattered in Europe, Asia, South America, and Australia. Done mostly in shades of red, ochre, brown and black, what is most striking about these paintings is the similarity of style in representing the animal forms and the overall format of the paintings found in places separated by thousands of kilometres.

The largest trove of cave paintings was discovered at

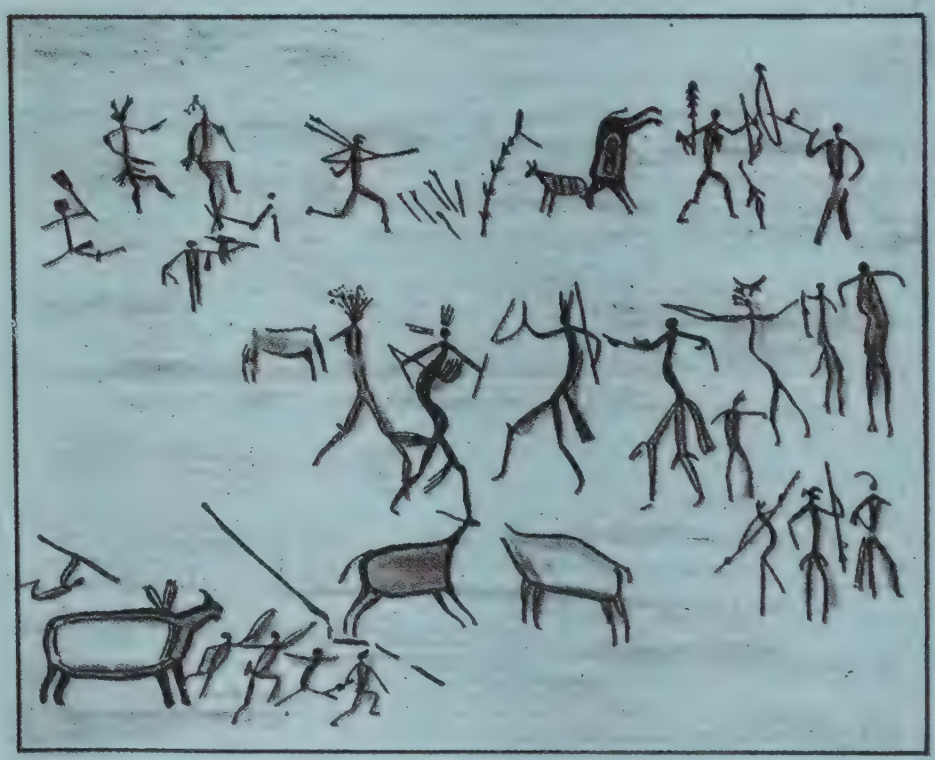
a place called Lascaux in southwest France, almost accidentally in 1940. A group of four boys in their teens were exploring the woods on a hillside overlooking the village of Montignac when they discovered a dark, deep hole that lay between the roots of a large tree. Daring as they were, the four decided to find out what lay behind the hole. They collected a few bits of rope, a knife and a home-made oil lamp. Then, on 12 September, after clearing the entrance of stones and undergrowth, they entered the cave one by one, unaware of what lay in store beyond the veil of darkness. Soon after, as they shone their oil lamp on to the dark walls of the cave, in the flickering light they saw familiar shapes of animals. They had stumbled upon one of the greatest treasures of prehistoric art ever discovered. Considering their antiquity—they were more than 17,000-years old—the paintings still appeared exceptionally fresh and were priceless.

There is no doubt that the cave artists who made those astonishing paintings used animal-fat lamp for illumination and some kind of scaffolding to reach the 5 m high ceilings where the paintings were created. In some of the caves, holes in the rock wall which probably held branches for a working platform are still visible.

The paints used by the cave artists came mostly from minerals such as red and yellow ochre, manganese oxide, haematite and other ores, which were often roasted, ground and mixed to produce different colours. The colours were probably mixed with fat to make the paint waterproof. Often cave water was used in which the dissolved calcium carbonate provided the durability. The paint was applied with twigs or fingers. Often the colour mixed with saliva was 'sprayed' on by squirting it from the mouth. This was probably the method used to produce the 'hand prints', thousands of which decorate cave walls at many Upper Palaeolithic sites.

The Lascaux caves have over 600 paintings and almost 1,500 engravings. The animals portrayed here

include big bulls, black horses, red and black deer, and even the mythical unicorn. But only one human figure has been located in the paintings. By sharp contrast, human figures abound in the paintings found in rock shelters in India. Several cave shelters with rock paintings have been discovered in India. Among them are rock shelters at Singhanpur in Raigarh district of Orissa, Ghatsila in Singhbhum district of Bihar, Mirzapur district in Uttar Pradesh, Bellary district in Karnataka and Bhimbetka in Madhya Pradesh. The rock paintings at Singhanpur depict hunting scenes with horses and deer, and masked dancing figures. The paintings in rock shelters in the Kaimur ranges in Mirzapur district of Uttar Pradesh show hunting scenes with men armed with harpoons attacking rhinoceroses. In the rock shelters in Bellary district, more than 20 groups of animal drawings and paintings of hunting



Cave paintings from Bhimbetka showing hunters with bows, arrows and spears chasing game

scenes with men armed with javelins and shields have been found.

But the most exciting discoveries of rock paintings in India were made at Bhimbetka, a hill-top site, 45 km south of Bhopal off the Bhopal-Hosangabad road. Here, more than 200 rock shelters, about 130 of them containing prehistoric paintings, were discovered in 1958 by V.S. Wakankar, an enthusiastic explorer of rock art in India. Done mostly in red and white, these paintings are not only the earliest record of art in India, but also provide valuable information about conditions prevailing in the region at the time they were created between 15,000 and 8,000 years ago.

The Bhimbetka paintings provide us a veritable catalogue of animal life that prevailed in the region thousands of years ago. They include the rhinoceros, tiger, elephant, wild buffalo and wild ox.

Unlike the Lascaux paintings, the rock paintings at Bhimbetka are replete with human figures. They depict humans riding on horse and elephant, some of them in what appear like hunting scenes. They also depict the various methods of hunting used—with spears, bows and arrows, and traps. There are also scenes of dancers with a drummer—not much different from those seen in many tribal communities of today.

Thousands of rock paintings dating back from 10,000 years ago have also been discovered in northern Australia. Here again, the animals depicted are those found in the region—kangaroos, crocodiles, emus, the Tasmanian tiger, and the rainbow snake, for example. The paintings also depict humans—warriors with elaborate head-dresses, spear-throwers—and also boomerangs, used by the Australian aborigines for thousands of years.

At a site in northeastern Brazil, called the Pedra Furada rock shelter, paintings, some of which date back to at least 10,000 years ago, have been discovered. These are said to be the oldest known cave art pieces in the Americas.

A peculiar feature of many of the cave paintings discovered in France is their relative inaccessibility. Most of the paintings are located in deep interiors of the caves which could be reached with much difficulty. Another interesting thing is that about a sixth of the painted animals bear markings that can be interpreted as spears or wounds. According to some authorities this could mean that the rock paintings and engravings may have been more than simple works of art as once thought. They probably were part of some elaborate ritualistic practice followed by Upper Palaeolithic people, a practice described as 'sympathetic magic'. Through art, it has been suggested, these people sought to increase the number of game animals and to ensure hunting success. Upper Palaeolithic people had, at least in Europe, penetrated deep underground to perform rituals for increasing game and ensuring success. Thus, in a way, they sought to exercise ritual control over predators. The artists ritually 'killed' their painted animals by drawing spears or wounds on their sides. Abstract shapes have been identified in the paintings which could be interpreted as traps and nets, drawn to capture the painted animals ritually.

There is also evidence of the use of underground cave art for certain social rituals, such as ceremonies initiating boys and girls into adulthood. Deep inside an underground cave at Le Tuc d'Audoubert in the French Pyrenees, 15,000-year-old clay models of a pair of bisons, a male and a female, have been discovered which appear in what looks like mating position. In a nearby chamber, footprints of several youths are frozen in clay, possibly record of a ritual dance performed during an initiation ceremony. Prehistoric art, after all, was not just a creative activity, it too had a purpose.

Whatever the motivation, there is no doubt that the artistic expertise of Upper Palaeolithic people peaked in France and Spain between 26,000 and 9,000 years ago, as evidenced by masterpieces of realism sculpted in stone,

bone, ivory and clay. These people may have also excelled at such crafts as woodcraft, but no evidence survives today. From whatever has withstood the ravages of time, it can be said with certainty that they were artists *par excellence*, especially when it came to depicting animal forms. Such fine animal art would not be seen again until the agricultural civilisations of later periods.

9

THE FIRST HARVEST

It is difficult to pin down the moment of birth of truly modern humans. By convention, as we have already seen, 40,000-year-old skeletons found by workmen digging for a railway line at Cro-Magnon near Paris are considered the first examples of modern humans. But not everyone agrees. It is argued that it was only when agriculture was becoming well established that modern man truly arrived on the scene. It may well be so, for it was only after humans gave up the nomadic life of foraging and hunting and began a settled life that cultures flourished. They developed skills to become artists, scientists, poets, novelists, explorers and what not. It was only after our ancestors learned to live a settled life that great civilisations evolved, which changed the face of the earth forever.

Twenty thousand years ago, our ancestors, who had by then reached almost all corners of the globe, were mostly foragers and hunters, depending mainly on wild animals and wild fruits and tubers for food. As millennia passed by, our wits got a little sharper, and, most important of all, our social and cultural fabric grew more elaborate and richly patterned, until, about 10,000 years ago, we stood at the threshold of a revolution that was to transform the world.

Around 12,000 years ago the last Ice Age was losing its grip over the continent. The vast ice sheet that covered much of northern Europe was receding. The climate was turning more salubrious. It was around this time that our ancestors discovered a new capability. They discovered

that they could grow crops for food without having to forage and gather it from the wild. It was the beginning of agriculture.

In Europe, the retreat of the ice sheet may have been an important factor in ushering in agriculture, but it was not unique. Groups of people elsewhere, too, embarked on this novel way of life at about the same time. Central America, the southeastern edge of the Mediterranean, and parts of South Asia, all have archaeological evidence of primitive agriculture beginning around 10,000 years ago. Around the same time, mankind also started domesticating animals—dogs, sheep and goats, the latter two for milk and meat. With food supply suddenly becoming assured and plentiful, mankind embarked on a new way of settled life.

Besides climatic factors, there was another important natural ingredient that was instrumental in ushering in the agricultural revolution—the appearance of two forms of wheat with a large, full head of seeds. Nearly 10,000 years ago, wheat was not the luxuriant plant it is today; it was merely one of the many wild grasses that grew in profusion in West Asia. Then, by some fortuitous genetic accident the wild wheat crossed with a different variety, called goat grass and formed a fertile hybrid that produced plump seeds. This was how a variety of wheat, called the 'Emmer' came into being. It had 28 chromosomes compared to the wild wheat's 14. The common bread wheat with 42 chromosomes came later, when Emmer wheat again crossed with natural goat grass. Thus it was a happy conjunction of natural and human events that triggered off the activity we call agriculture. In a way, it was the beginning of human civilisation.

The birthplace of agriculture was the hilly tracts of West Asia comprising present-day Israel, Jordan, Iraq, the Caspian basin and the adjoining Iranian plateau—commonly known as the 'fertile crescent'. It is in this region that wild ancestors of two major cereals—wheat and barley—and of domesticated animals like goat, sheep, pig and cattle

Primitive wheat varieties

are found. Thus the region had all the ingredients required for farming including fertile soil. However, how exactly the people who lived there stumbled upon the idea of growing food crops is not known. It is quite probable that the early settlers initially only harvested wheat but did not know how to plant it. It was possibly the accidental scattering of wheat seeds and their later germination in the ground that gave the early settlers the idea of cultivation by sowing.

Domestication of animals was a natural offshoot of the agricultural revolution. Domesticated animals like sheep, goats and cattle supply milk and meat, and their dung can be used as a rich manure. The hair of sheep and goats can be woven into cloth. Cattle can be used to draw ploughs and to carry loads.

Around the time agriculture was evolving, new innovations were also appearing in the tool-making skills of early humans, marking what came to be known as the Neolithic Age. It is typified by the appearance of more advanced, polished stone tools including the stone axe, with its carefully ground edge. This fine tool enabled the Neolithic man to obtain a foothold in the forests. In the forest clearings, these early farmers started the cultivation of crops. Very often, they used fire to burn down the trees and then plant grains of cereals in the clearing with pointed sticks, as is still done by many hill tribes in India.

Later on, stone-hoes with wooden handles were invented. The sowing of crops was largely the work of women, who may have been the real originator of agriculture. It was only after the domestication of cattle and the invention of the plough, which came much later, that women were liberated from the toil of cultivation. In many parts of India, even now, whereas ploughing is done by man, it is the woman who follows the plough and drops the seed in the furrows.

By about 4000 B.C., agriculture had become one of the most important productive enterprises of mankind in the

An early plough

eastern Mediterranean coastal region of West Asia.

In India, agriculture began with the practices of the inhabitants of the Indus Valley culture around 2500 B.C. The fertile alluvial soil, a heavy monsoon rainfall at that time and the water of the Indus were conducive to the growth of a number of domesticated plants. In fact, according to historians, the economy of the people of the Indus Valley civilisation was based on agricultural produce, which was quite substantial. But unlike the Mesopotamians, the Indus Valley people did not know the use of the plough. They used the toothed harrow for tilling land.

Agriculture in the Indus Valley mainly comprised cultivation of wheat, barley, cotton and peas. The interesting point about Indus Valley agriculture is that the remains of wheat unearthed at Mohenjo-daro belongs to a group which is still cultivated in modern Punjab.

The spread of agriculture engendered several other activities such as house building, pottery making, basketry and weaving. A settled life needed a permanent place to

live in. So arose the art of house building using sun-dried mud bricks. Walls made of sun-dried bricks were popular in West Asia and China. The walls were lined with lime plaster, as is still done in villages in India and many Third World countries.

The bounty of Nature that agriculture produced created the problem of storage leading to yet another innovation of great consequence—that of pottery making. Pots could be made from clay and used not only for storing foodgrains but also for cooking. Available evidence from West Asia indicate that the first pots were hand made from clay around 6000 B.C. The use of the wheel in making pottery came much later. What is of significance is the knowledge of firing clay pottery to make it strong and durable. The use of fired clay pottery no doubt made safe storage of foodgrains possible, but it did something more important. It changed the way food was made. Fired pottery extended the range of cooking operations beyond simple roasting over fire as practised by Neandertals. It improved the diet of man to levels never achievable before.

Among the other important innovations of the Neolithic period was the invention of basketry and weaving. Basketry also first appeared in West Asia, and was possibly instrumental in the development of weaving since both involve regularities and almost identical forms of patterns.

Not all experts, however, agree on the sequence of events that followed the first harvest of cultivated crop. According to Lewis Binford, the American archaeologist, many of the 'achievements' thought to flow naturally from the invention of agriculture, in fact, occurred first in other contexts. Pottery, he says, first appeared in Japan among hunting and gathering peoples dependent on the sea. Other evidence point to the fact that a knowledge of agriculture and domesticated plants existed long before people gave up hunting and gathering and settled for agriculture.

Whatever the sequence, by about 3000 B.C. mankind

had attained almost all the intellectual capabilities that would subsequently blossom into the myriad of activities in the fields of arts, music, literature, science and technology and set the pace for the various path-breaking discoveries of the later millennia.

Standing on the threshold of the twenty-first century, it appears amazing how swiftly mankind has changed in just 10,000 years since the agricultural revolution began, compared to what went on during the previous 2 million years or so. It took at least 2 million years to change from the little dark creature called *Australopithecus*, with stone in his hand, to early modern humans. That is the pace of biological evolution. With the appearance of spoken words, everything changed, culminating in the blossoming of cave art in the Upper Palaeolithic. But it was not until mankind learnt to live a settled life and grow his own food that cultural evolution could take root. Freed from the worries and tribulations of a nomadic life, mankind could now expend his energies in more creative and productive activities. In that sense, the beginning of agriculture truly marks the birth of modern humans.

10

THE QUESTION OF AGE

Scientists who explore the past from fossil records use many different methods to find out how old a fossil is. Most of the dating methods are based on what is known as the 'half-life' of radioisotopes. Radioisotopes, as we know, are isotopes of ordinary atoms with more neutrons in their nuclei. All radioisotopes are unstable atoms and give off radiation in the form of alpha, beta or gamma rays. In the process they change into a more stable atom of a different element.

What is unique about radioisotopes is that each of them 'decays' or changes into a stable atom at a fixed rate which is characteristic of each of them. Scientists usually express this rate of decay as the `half-life' of a particular radioisotope. Half-life is a measure of the time it takes for half the number of atoms of a radioisotope in a sample to decay. Since the rate is constant, from the amount of a radioisotope present in a sample (actually the ratio between the radioisotope and its stable decay product is measured), the age of the sample can be determined.

Half-life of radioisotopes range widely—from a fraction of a second to several million years. Two of the most commonly used dating methods are based on the naturally occurring radioisotopes—carbon-14 and potassium-40.

When dealing with samples dating back to a few million years, as most early prehuman fossils are, they use what is known as the 'potassium-argon dating' method. It makes use of the property of the radioactive isotope potassium-40 with a half-life of 1,250 million years and found in

all rocks, to turn into the rare gas argon-40 by radioactive decay. In rocks formed from volcanic ash or lava, any argon gas produced before formation of the rock is taken as escaped, that is, only gas produced after a volcanic eruption is taken into account. Since the rate at which potassium-40 atoms turn into argon-40 is known from its half-life, by measuring the amount of argon trapped in the rock layer in which a fossil jaw or skull is found embedded, the age of the fossil can be calculated with reasonable accuracy. But only fossils older than 100,000 years of age can be dated using the 'potassium-argon method'. Fossils of younger age cannot be dated by this method because the amount of argon-40 formed by decay would be too small.

Another widely used dating method makes use of the decay of the radioactive isotope carbon-14 which has a half-life of 5,730 years and is present in all living things. Carbon-14 is produced in the upper atmosphere from nitrogen-14 by reaction with neutrons present in cosmic rays. Plants and animals absorb carbon dioxide from the air as long as they live, taking in one carbon-14 atom for every million million atoms of non-radioactive carbon-12. When they die, they do not take in any more carbon-14. On the other hand, whatever carbon-14 they already have starts breaking down. As a result, the ratio of carbon-14 to carbon-12, which remains constant over an organism's life-time, begins to change. Again, since the rate at which carbon-14 atoms break down is known, from the measured carbon-14 to carbon-12 ratio, the age of a sample can be worked out. The 'radiocarbon dating' method is unreliable for samples older than 40,000 years of age as the amount of carbon-14 still remaining in the sample becomes too small to be measured accurately.

For samples of age between 40,000 years and 100,000 years, a third technique comes in handy. It makes use of a phenomenon called *thermoluminescence* in which light is emitted on heating a sample to 300° to 600°C. The light is produced by the release of electrons trapped in previously

fired pottery or heated rock over a period of time and the intensity of the light produced is proportional to the number of trapped electrons. The electrons accumulate in the samples dué to exposure to natural radiation such as cosmic rays. If the sample is very old, it would have been exposed to radiation for a much longer time than it would have been if it were of lesser age. As a consequence, an older sample would accumulate more electrons and when heated would give off more light than a sample of lesser age. The light produced by heating can be measured and from the intensity the age of the sample can be worked out.

Recommended Reading

Bryant, Vaughn M.: 'In Search of the First Americans', *Yearbook of Science and the Future*, 1993 (Encylopaedia Britannica Inc. 1992).

Coppens, Yves: 'East Side Story: The Origin of Humankind', *Scientific American*, May 1944.

Fischman, Joshua: 'Hard Evidence', *Discover*, February 1992.

Foley, Robert: *Humans before Humanity* (Blackwell, 1995).

Gore, Rick: 'Neandertals', *National Geographic*, January 1996.

Gribbin, John and Mary Gribbin: *Children of the Ice* (Basil Blackwell).

Johanson, Donald C.: 'Face-to-Face with Lucy's Family', *National Geographic*, March 1996.

Johanson, Donald C.: 'First 'Family' of Early Man', *National Geographic*, December 1976.

Leakey, Mary: *Olduvai Gorge* (Collins, 1979).

Leakey, Mary D.: 'Footprints Frozen in Time', *National Geographic*, April 1979.

Leakey, Meave: 'The Dawn of Humans', *National Geographic*, September 1995.

Leakey, Richard: *The Origin of Humankind* (Phoenix, 1995).

Leakey, Richard and Alan Walker: '*Homo Erectus* Unearthed', *National Geographic*, November 1985.

Leakey, Richard and Roger Lewin: *Origins Reconsidered* (Abucus, 1993).

Leakey, Richard and Roger Lewin: *People of the Lake* (Collins, 1979).

Lewin, Roger: *Bones of Contention* (Touchstone, 1988).

Lovejoy, C. Owen: 'The Evolution of Human Walking', *Scientific American*, November 1988.

Putman, John J.: 'The Search for Modern Humans', *National Geographic*, October 1988.

Shipman, Pat: 'Baffling Limb on the Family Tree', *Discover*, September 1986.

Shreeve, James: 'Argument over a Woman', *Discover*, August 1990.

Shreeve, James: '*Erectus* Rising', *Discover*, September 1994.

Shreeve, James: 'Sunset on the Savanna', *Discover*, July 1996.

Shreeve, James: 'The Neanderthal Peace', *Discover*, September 1995.

Stringer, Christopher: 'The Emergence of Modern Humans', *Scientific American*, December 1990.

Tattersall, Ian: *The Fossil Trail* (Oxford University Press, 1995).

The Cambridge Encyclopedia of Human Evolution, Cambridge, 1992.

Toth, Nicholas: 'The First Technology', *Scientific American*, April 1987.

Weaver, Kenneth F.: 'The Search for Our Ancestors', *National Geographic*, November 1985.

Willis, Christopher: *The Runaway Brain* (Harper Collins, 1994).

Wood, Bernard: 'Antiquity of Man in Africa', *Yearbook of Science and the Future, 1978* (Encyclopaedia Britannica Inc. 1977).

Index

Aegyptopithecus 5, 6, 11
Afar 11, 17
agriculture 71, 76
Apes, African 3, 10, 13
Aramis 17
Aridipithecus ramidus 17
art, Palaeolithic 63-69
Australopithecus anamensis 17
Australopithecus boisei 21, 22, 25, 27
Australopithecus robustus 19, 21, 22, 25, 28
Australopithecus afarensis 8, 12-19
Australopithecus africanus 18- 20, 22

Beringia 62
Bhimbetka 56, 66, 67
Binford, Lewis 41, 42, 75
bipedalism 11
Boise, Charles 21
brain 48-52
Broca's area 25, 50, 51, 52
Broom, Robert 19

carved figurines 64
cave paintings 64-68
colour vision 4
Cro-Magnon man 54, 56, 58
Cro-Magnon 54, 55, 70

Dart, Raymond 18, 23
Darwin, Charles 1-4, 45
dating methods 77-79
Descent of Man, The 1, 3
DNA 8, 55
domestication 73
Dryopithecus 6
Dubois, Eugene 29
dwellings 59

'Eve' 55

Fayum 5, 6
'fertile crescent' 71
fire, use of 33, 41, 42, 58
'First Family' 15

global cooling 10, 27

Hadar 11, 15, 28
Haeckel, Ernst 29, 30
Halloway Ralph 51
Hill, Andrew 12
Homo erectus 18, 28, 30, 32-36, 40, 50, 55
Homo habilis 22-28, 33, 51, 52
Homo neanderthalensis 38
Homo sapiens 38, 44
Homo sapiens sapiens 44, 52, 54, 55
Homo sapiens neanderthalis 55
Huxley, Thomas Henry 2, 3, 38, 45

Ice Age 28, 34, 56, 70
Indus Valley 74

Java man 30, 32
Johanson, Donald 8, 11, 12

Kanapoi 17
Kenyapithecus 6
Kimbel, William 28
Koobi Fora 23, 24, 26,.27
Laetoli 11, 12
Laitman, Jeffrey 50
lamp 58
Lascaux cave 57, 65, 67
Leakey, Richard 17, 23, 24, 32, 38
Leakey, Mary 12, 20
Leakey, Louis S.B. 12, 21, 23
Leakey Meave 17
Lewis, G. Edward 8
Lucy 11-16, 18

Man's Place in Nature 3, 38, 45
migration 61, 62

Nariokotome 30, 32
Narmada Valley 34
Neandertals 18, 37-44, 55, 56, 58, 63, 75
Neolithic Age 73, 75

Olduvai Gorge 20, 23, 26
opposable thumbs 4
Origin of Species 1, 3

Pie, W.C. 30
Peking man 30, 32
Pilbeam, David 8
Pilgrim, Guy 8
Pithecanthropus 18, 29, 30
potassium-argon dating 77
pottery 75
Proconsul 6

Quafzeh 54

radiocarbon dating 78
Ramapithecus 6, 8, 9, 11, 22
Rudapithecus 6

sewing 60
Sinanthropus pekinensis 30
Sivapithecus 6
Siwalik Hills 6, 8
skin colour 35, 36
speech 5, 25, 44, 45-53
Spencer, Herbert 2
Sterkfontein 19, 20, 21
stone tools 16, 26
'Survival of the fittest' 2
sympathetic magic 68

Taung child 18, 19
thermoluminescence 54, 78
Trinil 29
Turkana boy 32, 36
Turkana, Lake 21, 23, 32

Upper Palaeolithic 56, 58, 60, 63, 64, 65, 68, 76

Voice-producing organ 25, 41, 45, 47, 52

Walker, Alan 32
Wernicke's area 50
wheat 71
White, Tim 17
woolly mammoth 59
Zinzanthropus boisei 21

ಕರ್ನಾಟಕ ಗಾಂಧೀ ಸ್ಮಾರಕ ನಿಧಿ (ರಿ)
ಪರಿಗ್ರಹಣ ಸಂಖ್ಯೆ:
ACC. No.: 11626
ಗಾಂಧೀ ಗ್ರಂಥಾಲಯ, ಬೆಂಗಳೂರು-4

Printed at Bengal Offset Works, New Delhi

The story of man's evolution from the lowly tree-dwelling ape has all the ingredients of a thriller. As new clues emerge from fossil evidence, the story takes dramatic twists and turns. However, in the end everything appears to fall into place. This profusely illustrated book gives an account of the many exciting discoveries and the relentless efforts of scientists that eventually led to our present understanding of where we came from. It traces how our distant ancestors gave up a life on the trees and learnt to walk on two feet, use tools and fire, and talk as we humans do now.

Biman Basu (*b.* 1945), who postgraduated in chemistry from the University of Delhi, began his career as a lecturer in Hans Raj College. He then joined the Council of Scientific & Industrial Research as assistant editor of their science journal. Between 1974 and 1977 he was on deputation to All India Radio as a science correspondent. He rejoined CSIR in 1977 and is currently the editor of *Science Reporter* and heads the production unit of the National Institute of Science Communication. Besides contributing science articles to leading national dailies and monthlies, he has written two popular science books in Bengali and one in English—*Inside Stars*. He is winner of the 1994 NCSTC National Award for best science and technology coverage in the mass media.

₹ 55.00

ISBN 978-81-237-2057-9

NATIONAL BOOK TRUST, INDIA